2024 7th International Conference on Aeronautical, Aerospace and Mechanical Engineering

AAME 2024

New Developments of Unmanned Aerial Vehicles Technologies in Asia Pacific Region

March 8-10, 2024| Hong Kong

Co-sponsored by

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Conference Committees

Conference Chairs

Prof. John Mo, Royal Melbourne Institute of Technology, Australia

Prof. Lixi Huang, The University of Hong Kong, Hong Kong

Conference Co-chair

Prof. Yan Wang, Nanjing University of Aeronautics and Astronautics, China

Technical Program Chairs

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Prof. Zheng Hong Zhu, York University, Canada

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Prof. Wenlin Wang, Dongguan University of Technology, China

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Assoc. Prof. Chrystal Zhang, Royal Melbourne Institute of Technology, Australia

Asst. Prof. Min Zhou, Northwestern Polytechnical University, China

Dr. GUELAILIA Ahmed, Space mechanics research department, Satellite development center, Algerian Space Agency, Algeria

Dr. Pan LU, Beijing Institute of Mechanics and Electricity, China

Dr. S. M. Anas, Jamia Millia Islamia (A Central University), India

Zohreh Molamohamadi, Kharazmi University, Tehran, Iran

Dr. Masoud Taghavi, Chung-Ang University (CAU) in Seoul, South Korea

Dr. Zhihui Liu, Tsinghua University, China

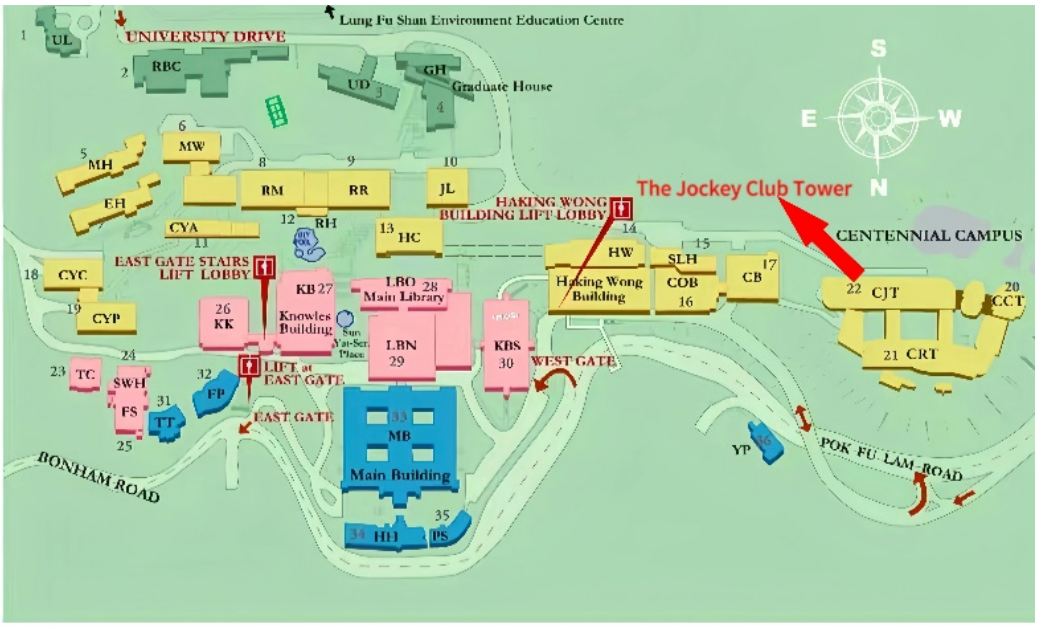
Dr. Anuj Kumar Shukla, National Institute of Technology Raipur, India

Conference Venue

香 港 大 學
THE UNIVERSITY OF HONG KONG

The University of Hong Kong

- **Mar. 8, 2024: Sign-in and Conference Kits Collection& Technical Tour- Haking Wong Building**
- **Mar. 9, 2024: Keynote Speeches & Oral Sessions- The Jockey Club Tower**



Main Campus Map

[01] UL - University Lodge
[02] RBC - Robert Black College
[03] UD - University Drive No.2
[04] GH - Graduate House

[05] MH - May Hall
[06] MW - Meng Wah Complex Building
[07] EH - Eliot Hall
[08] RM - Runme Shaw Building
[09] RR - Run Run Shaw Building
[10] JL - James Hsioung Lee Science Building
[11] CYA - Chong Yuet Ming Amenities Centre
[12] RH - Rayson Huang Theatre
[13] HC - Hui Oi Chow Science Building
[14] HW - Haking Wong Building
[15] SLH - Simon K.Y. Lee Hall
[16] COB - Composite Building
[17] CB - Chow Yei Ching Building
[18] CYC - Chong Yuet Ming Chemistry Building
[19] CYP - Chong Yuet Ming Physics Building
[20] CCT - Cheng Yu Tung Tower (Law)
[21] CRT - Run Run Shaw Tower (Arts)
[22] CJT - The Jockey Club Tower (Social Sciences)

[23] TC - Tang Chi Ngong Building
[24] SWH - Swire Hall
[25] FS - Fong Shu Chuen Amenities Centre
[26] KK - K.K. Leung Building
[27] KB - Knowles Building
[28] LBO Main - Library Building (Old Wing)
[29] LBN - Library Building (New Wing)
[30] KBS - Kadoorie Biological Sciences Building

[31] TT - T.T. Tsui Building
[32] FP - Fung Ping Shan Building
[33] MB - Main Building
[34] HH - Hung Hing Ying Building
[35] PS - Pao Siu Loong Building
[36] YP - Yam Pak Building

Conference Venue

Conference Rooms

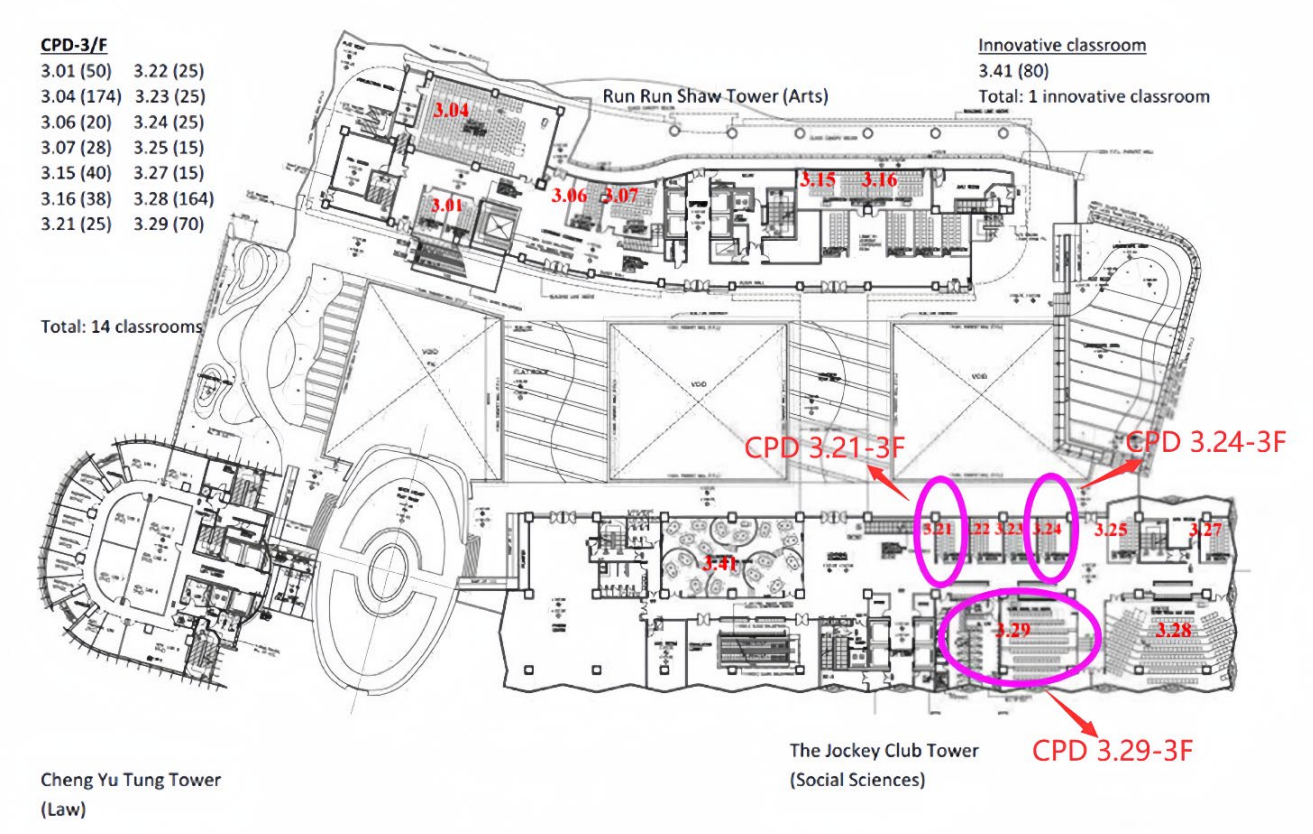
Mar. 8th, 2024

Sign-in and Conference Kits Collection - 705(7F), Haking Wong Building

Mar. 9th, 2024

Opening Ceremony & Keynote Speeches: CPD 3.29-3F, The Jockey Club Tower

Session 1&Session 3: CPD 3.21-3F, The Jockey Club Tower
Session 2&Session 4: CPD 3.24-3F, The Jockey Club Tower



Onsite Instruction

Time Zone: GMT+8 (Beijing Time)

Oral Presentation

1. Timing: a maximum of 15 minutes total, including speaking time and discussion. Please make sure your presentation is well timed.
2. You can use USB flash drive (memory stick), make sure you scanned viruses in your own computer. Each speaker is required to meet her/his session chair in the corresponding session rooms 10 minutes before the session starts and copy the slide file (PPT or PDF) to the computer.
3. It is suggested that you email a copy of your presentation to your personal inbox as a backup. If for some reason the files can't be accessed from your flash drive, you will be able to download them to the computer from your email.
4. Please note that each session room will be equipped with a LCD projector, screen, point device, microphone, and a laptop with general presentation software such as Microsoft PowerPoint and Adobe Reader. Please make sure that your files are compatible and readable with our operation system by using commonly used fonts and symbols. If you plan to use your own computer, please try the connection and make sure it works before your presentation.
5. Videos: If your PowerPoint files contain video clips, please make sure that they are well formatted and connected to the main files.

Dress Code

Please attend the conference in formal attire.

Safety Reminder: Secure Valuable Items at All Times

- Wear your Conference Identification Badge at all times. Do not throw away the Badge.
- If you are using a laptop computer, do not leave it unattended at any time.
- Keep your purse, wallet and other valuables with you at all times.
- The conference organizer will not be responsible for the loss or damage to any personal belongings.

Online Instruction

Time Zone: GMT+8 (Beijing Time)

Platform

We will be using Zoom for all our live stream sessions. So, if you haven't installed it, please download a Zoom client from: https://zoom.us/download
The Zoom account is not mandatory to attend the conference. If you do not want to register the account, by entering meeting ID is also accessible to our conference.
Learn the Zoom skills at: https://support.zoom.us/hc/en-us/articles/206618765-Zoom-Video-Tutorials

Join the Test Session before the Formal Session

Date: Mar.8th , 2024
Prior to the formal meeting, presenters shall join the test room to ensure everything is on the right track. Please check your test time on this program.
The Video presentation should be within 12 minutes, 3 minutes for Q&A, in total, one presentation is 15 minutes.

Equipment Needed

- A computer with internet connection and camera
- Headphones

Environment Needed

- Quiet Location
- Stable internet connection
- Proper lighting and background

Attention Please

The conference will be recorded. We will appreciate your proper behavior.

Presentation Recording and Broadcasting

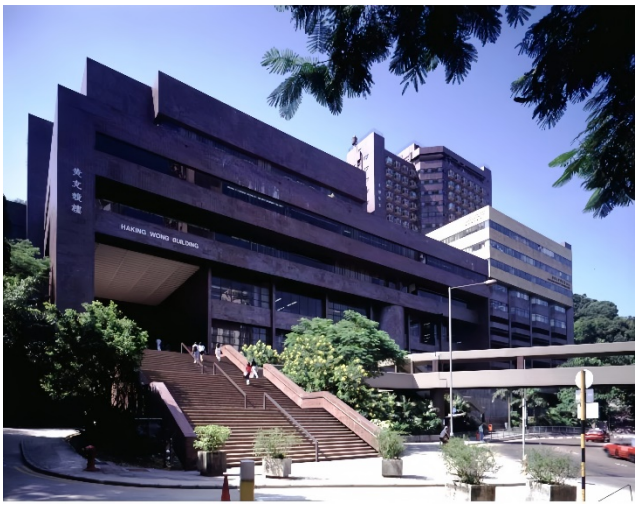
The photograph(s) or video or audio recording(s) will be taken by conference organizer. It will be used in for conference program purpose. The photograph(s) or video or audio recording(s) will be destroyed after the conference, it cannot be distributed to or shared with anyone, it shall not be used for commercial nor illegal purpose. Each presentation will be recorded, if you don't want it, please inform our staff ahead of time.
Do not record other presenters' presentation nor distribute it to or share with anyone unless the presenter gives written consent of agree. Failure to do so will be considered a serious academic violation subject to disciplinary/ lawful action.

Schedule On Mar. 8th

Day 1 | Mar. 8, 2024 (Friday)

Time	Activity	Venue
09:30-12:00 13:30-17:00	Sign-in and Conference Kits Collection	**705(7F), Haking Wong Building**
14:00-16:30	Technical Tour	Haking Wong Building
Online Meeting Test		
Zoom ID: 874 7839 6462 (Link: https://us02web.zoom.us/j/87478396462)		
13:30-15:30	Session 5 & Session 6 AA24-210, AA24-211, AA24-269E, AA24-234E, AA24-275E, AA24-235, AA24-270E, AA24-241, AA24-244, AA24-263, AA24-268E, AA24-271E, AA24-215, AA24-203, AA24-246E	

Haking Wong Building



Dr. Haking Wong (HonLLD 1980) was a renowned electronics engineer dedicated to industrial development in Hong Kong. The late entrepreneur donated generously to engineering research, and the University named the Haking Wong Building in recognition of his generosity. The building was opened on 6 October, 1983 by Sir Edward Youde, the then Governor and Chancellor of HKU. Haking Wong Building is a complex consisting of engineering laboratories, Simon K. Y. Lee Hall and Hsu Long Sing Amenities Centre.

Schedule On Mar. 9th

Day 2 |Mar. 9, 2024 (Saturday)

Time	Activity		Venue
Zoom Link: https://us02web.zoom.us/j/87478396462			
09:00-09:05	Opening Remark	**Prof. John Mo** Royal Melbourne Institute of Technology, Australia	CPD 3.29/3F The Jockey Club Tower
09:05-09:10	Welcome Address	**Prof. Lixi Huang** The University of Hong Kong, Hong Kong	
Host: Prof. John Mo, Royal Melbourne Institute of Technology, Australia			
09:10-09:55	Keynote Speech I	**Prof. Ben M. Chen** Chinese University of Hong Kong (CUHK), Hong Kong *Topic: Advanced Unmanned and AI Systems for Infrastructure Inspection and Management*	
9:55-10:40	Keynote Speech II	**Prof. Yuehong Qian** Soochow University, China	
10:40-11:10	Group Photo & Coffee Break		
11:10-11:55	Keynote Speech III	**Prof. Xin Zhang** Hong Kong University of Science and Technology, Hong Kong *Topic: The Noise Impact of Urban Air Mobility*	CPD 3.29/3F The Jockey Club Tower
11:55-13:30	Lunch @ CPD 3.24/3F, The Jockey Club Tower		
14:00-18:00	Technical Sessions		
14:00-15:30	Session 1	*Mechanical Structure Defect Detection and Performance Analysis* AA24-201-A, 212, 239E, 242, 267E, 272E	CPD 3.21/3F
14:00-15:45	Session 2	*Image Based Intelligent Control System and Application* AA24-276-A, 218E, 214, 217, 249, 253E, 259	CPD 3.24/3F
15:45-16:15	Coffee Break		
16:15-18:00	Session 3	*Avionics Systems and Wing Aerodynamic Analysis* AA24-201-E, 204-A, 245-A, 252-A, 260, 264, 261	CPD 3.21/3F
16:15-17:45	Session 4	*Aircraft Engine Model and Hybrid Power System* AA24-206, 225, 208, 207, 256, 209	CPD 3.24/3F
18:30-20:00	Dinner Banquet @ Ming Pavilion 明軒, 14/F, KK Leung Building, HKU		

Schedule On Mar. 10th

Day 3 | Mar. 10, 2024 (Sunday)

Online Sessions		
Zoom ID: 874 7839 6462 (Link: https://us02web.zoom.us/j/87478396462)		
10:00-11:45	Session 5	*Modern Machinery and Control Technology* AA24-210, AA24-211, AA24-269E, AA24-234E, AA24-275E, AA24-235, AA24-270E
11:45-13:00	**Lunch Break**	
13:00-15:00	Session 6	*Control Model and Simulation in Aviation Systems* AA24-241, AA24-244, AA24-263, AA24-268E, AA24-271E, AA24-215, AA24-203, AA24-246E
One Day Tour		
09:00-19:00	The University of Hong Kong → Wong Tai Sin Temple → Lunch → Avenue of Stars → The Star Ferry → Golden Bauhinia Square → Famous Filming Location (Central-Mid-Levels Escalator and Walkway System & Pottinger Street) → Victoria Peak → 19:00 End at The University of Hong Kong Detailed information please refer to Page. 32.	

Keynote Speaker I

Mar. 9th | 09:10-09:55 CPD 3.29/3F
ZOOM ID: 874 7839 6462
https://us02web.zoom.us/j/87478396462

Prof. Ben M. Chen

Chinese University of Hong Kong (CUHK), Hong Kong
Fellow of IEEE / Fellow of Academy of Engineering, Singapore

BIO: Ben M. Chen is currently a Professor of Mechanical and Automation Engineering at the Chinese University of Hong Kong (CUHK). Before joining CUHK in 2018, he was a Provost's Chair Professor in the Department of Electrical and Computer Engineering at the National University of Singapore, where had worked for 25 years. He was an Assistant Professor in the Department of Electrical Engineering at the State University of New York at Stony Brook, USA, in 1992–1993, and was a Software Engineer at South China Computer Corporation, China, 1983–1986. His current research interests are in unmanned systems and their applications.

Professor Chen is an IEEE Fellow and Fellow of Academy of Engineering, Singapore. He has authored/co-authored hundreds of journal and conference articles, and ten research monographs in control theory and applications, unmanned systems and financial market modeling. He has served on the editorial boards of a dozen international journals including Automatica and IEEE Transactions on Automatic Control. He is currently serving as an Editor-in-Chief of Unmanned Systems and an Editor of International Journal of Robust and Nonlinear Control.

Advanced Unmanned and AI Systems for Infrastructure Inspection and Management

Abstract: In this talk, we aim to present the recent development of some unconventional unmanned systems and a fully autonomous infrastructure inspection and information management system with advanced AI and UAS technologies. The autonomous inspection system includes sophisticated unmanned hardware platforms and software systems for automatic flight control, task and motion planning, and AI techniques for RGB image and infrared data processing for defect detections. Topics on building information modeling (BIM) and management system integrated with detailed geographical information systems (GIS) and digital twin (DT) technologies will also be highlighted. Compared with the manual inspection, the autonomous inspection system that we have developed has the advantages of being more economical, safer, flexible and efficient. It can also be adopted for other industrial applications, including smart ocean and smart cities.

Keynote Speaker II

Mar. 9th | 09:55-10:40 CPD 3.29/3F
ZOOM ID: 874 7839 6462
https://us02web.zoom.us/j/87478396462

Prof. Yuehong Qian

Soochow University, China

BIO: After the bachelor degree in aero-engine from the Beijing University of aeronautics and astronautics, Dr. Yuehong Qian obtained his PhD in physics from Ecole Normale Superieure in and fluid mechanics from Uinersity Pierre et Marie Curie. He spent some times at the Institute of CFD in Tokyo, then he went to work at Princeton University and Columbia University as research staff member and assistant professor in applied mathematics and computational physics. He started his scientific works on lattice gas models for hydrodynamics, then he pioneered in lattice Boltzmann method since 1980s. He had worked as the principal scientist at the Exa Corp (now purchased by Dassault Systemes) for developping the commercial code PowerFLOW, which is widely used for solving aeroacoustic problems in automobile and aeronautical industries.

Keynote Speaker III

Mar. 9th | 11:10-11:55 CPD 3.29/3F
ZOOM ID: 874 7839 6462
https://us02web.zoom.us/j/87478396462

Prof. Xin Zhang

Hong Kong University of Science and Technology, Hong Kong
Swire Professor of Aerospace Engineering

BIO: Zhang Xin is the Swire Aerospace Engineering and a chair professor at the Hong Kong University of Science and Technology. He serves as the director of the Aerodynamics and Acoustics facility at HKUST. He holds a PhD from Cambridge University and is a fellow of the Royal Aeronautical Society and a fellow of the Hong Kong Institution of Engineers. Zhang Xin is mainly engaged in research and development in the fields of aerodynamics and noise of aircraft, aero engines, and unmanned air systems. He served as the Airbus Professor of Aircraft Engineering and was Director of the Airbus Aircraft Noise Technology Center from 2008 to 2015. He joined the HKUST in 2015. His research team (https://aantc.ust.hk/) maintains close cooperation with aerospace industry. He also conducts research in racing cars and sports aerodynamics. He has worked closely with the F1 racing industry and developed the world's first MSc course in racing aerodynamics at the University of Southampton, UK. In the field of sports science and technology, especially aerodynamics, his team collaborates with national, professional sports teams, and sports industries to engage in sports science and technology research. In addition, he also serves as the director of the HKUST-Hong Kong Sports Institute Joint Center for Sports Technology and the HKUST Sports Engineering Research Center at HKUST.

The Noise Impact of Urban Air Mobility

Abstract: Urban air mobility (UAM) is an emerging transportation system that uses flying vehicles to transport passengers and goods in cities and suburbs. It aims to improve the traffic congestion problem in urban settings. Development of electric propulsion, batteries, and autonomous flight technologies has led to the emergence of various UAM concepts and prototypes. However, noise pollution is a key factor limiting the development of UAM and will affect the public's acceptance of transport mode. UAM aircraft has a rich variety of noise sources. This talk outlines a systematic work to develop a UAM noise assessment platform, including computational aeroacoustics simulation on a large computing platform, boundary element method for noise scattering effects, Gaussian beam tracking combining atmospheric flow and flight motion for efficient calculation of long-distance noise propagation, terrain modeling, and low-noise route planning, etc. This platform can be used to guide the design of low-noise UAM aircraft, realize low-noise emission path planning, and contribute to the sustainable development of low-altitude flight in green cities.

Session 1

Session 1- Mechanical Structure Defect Detection and Performance Analysis
Chairperson: Prof. John Mo, Royal Melbourne Institute of Technology, Australia

Time: 14:00-15:30, Mar. 9th, 2024	Room: CPD 3.21-3F, The Jockey Club Tower

*Note: The schedule of each presentation is for reference only. Authors are required to attend the whole session, in case there may be some changes on conference day. Please join in the room 5-10 minutes earlier.

14:00-14:15
AA24-201-A

Optimization and Analysis of Cockroach Digestive System-Inspired Thin-Walled Metamaterials for Energy Absorption Structures

Yen-Song Xu, **Shyh-Chour Huang**
National Kaohsiung University of Science and Technology, Taiwan

Abstract: The research is based on bio-inspired thin-walled metamaterial structures inspired by the cockroach digestive system. Four different cross-sectional structures were designed, each with variations in three design parameters: length (angle, radius), inner circle radius, and thickness. Three output objectives were selected: axial direction specific energy absorption (AXSEA), radian direction specific energy absorption (RDSEA), and initial peak crushing force (IPCF). Finite element analysis was conducted using ABAQUS 2018 for quasi-static simulations, and the results were validated with actual quasi-static compression tests. The experimental and simulated errors were reported for AXSEA (5.74% error), RDSEA (5.05% error), and IPCF (4.99% error). Folding element theory was applied to calculate the average axial crushing force for bio-inspired structures, and it was found that structure 4 exhibited a larger error when the arc was simplified into a straight line. Artificial neural networks combined with multi-objective genetic algorithms were used to optimize the structural dimensions. The Pareto front was obtained, and the TOPSIS method was used to select the best size configuration with a ratio of 0.4, 0.3, 0.3. The study also investigated the influence of design parameters for structure 1, where thickness (t) was fixed at 0.5 mm. The effects of length (L) and inner circle radius (R) on the output objectives were studied when length (L) and inner circle radius (R) were fixed at 11 mm and 4 mm, respectively. The influence of thickness (t) on the output objectives was explored.

14:15-14:30
AA24-212

AHA-Kriging Surrogate Model Method for Surface Partition Flaw Tolerance Assessment of Turbine Blade

Jiongran Wen, Baiyang Zheng, Chengwei Fei
Fudan University, China

Abstract: The high-pressure turbine blade in aero-engine power system may experience micro-structural degradation due to uncertain flaws, multi-physical fields and loads during manu-facturing, processing, installation, and maintenance, leading to serious structure deterioration that affects safety and reliability in service. Therefore, it is necessary to assess the influence of random flaws and loads on the fatigue performance of turbine blades from a probabilistic perspective. In this study, we propose a novel method based on the Artificial Hummingbird Algorithm and Kriging surrogate model (AHA-Kriging), for flaw tolerance assessment in the surface partition of the turbine blade. The results indicate that in the hazardous zone, the flaw tolerance reliability is 0.9984, corresponding to a LCF life of 1520 cycles. In the safe zone, the flaw tolerance reliability is 0.9991, corresponding to a LCF life of 2501 cycles. The primary factor influencing LCF life is flaw size, followed by factors such as the strength coefficient, gas temperature, and fatigue strength exponent. Besides, the AHA-Kriging approach exhibits higher modeling precision and simulation efficiency compared to other methods. This paper presents a practical engineering approach for assessing flaw tolerance in the surface partition of complex components, which is of significant value.

14:30-14:45
AA24-239E

Development of Large-scale Bending and Torsional Test Rig Using Strong Floor Anchorage System for Structural Analysis

M F Abdul Hamid, **Mohd Shukri Bin Yob**, J S Vishnu, M M Izahar
Universiti Teknikal Malaysia Melaka, Malaysia

Abstract: The common practice among researchers is to use scaled models for validation. However, using scaled models can lead to errors due to the scaled factor. To overcome this problem, this paper presents the development of a large-scale bending and torsional test rig for structural analysis which is involves testing the actual scaled model of the structure. In this research, a portal frame powered by a hydraulic system anchored to a strong floor is developed to evaluate specimens' sizes up to 6 m x 2 m, such as planar frame and space frame structures. The design of the strong floor and the test rig will be analyzed for three-point bending, four-point bending and torsional tests. For stress analysis, it was found that the design of the test rig is capable of carrying out three-point bending test up to 37.6 kN, four-point bending test up to 75.2 kN, and torsional testing up to 4.1 kN.

14:45-15:00
AA24-242

Development and Application of the Sliding Plane Method for Turbomachinery

Yeqi Zhou, Jue Fu, Zhouteng Ye, Wei Sun, Jiahuan Cui
Zhejiang University, China

Abstract: This study focuses on the development and application of the sliding plane method for turbomachinery. The implementation of sliding plane consists of two parts:(1) grid manipulation in pre-processor and (2) sliding mesh interpolation in solver. In pre-processor phase, mesh extrusion, donor-receptor search pairing, and geometric array updates algorithms are implemented. Based on the updated grid information in pre-processor phase, flux interpolation between pairwise sliding planes is developed for unsteady Raynolds-averaged simulation (RANS). To validate the performance of our sliding plane method, the comparative simulation with the mixing plane method on Transonic Compressor Darmstadt (TCD) at Technical University of Darmstadt (TUDa) case is conducted using both sliding boundary and hybrid boundary methods. Special concern is placed on the stall phenomena near the leading edge of the compressor under near-stall conditions. Numerical results show superior agreement with experimental data compared to the mixing plane results, affirming its effectiveness in simulating unsteady conditions.

15:00-15:15
AA24-267E

Applied To Calibrate the New Intelligent Bearing of Nicr/Nisi Film Thermocouple

Zhihui Liu, Tengda Guo, Yongjun Cheng, Bi Wang, Kai Shen, Kai Hu, Jiankang Zhou, Chuan bing Zhang, Zixi Wang, Wanyu Ding
Tsinghua University, China

Abstract: The purpose of this paper is to study the calibration method of new intelligent bearing applied to NiCr/NiSi film thermocouple. Firstly, the basic principle and characteristics of NiCr/NiSi film thermocouple and intelligent bearing are introduced, and then the design and realization process of intelligent bearing are elaborated, including material selection, structural design, manufacturing process and so on. Then, this paper puts forward the calibration method of intelligent bearing, and verifies its effectiveness through experiments. The experimental results show that the Seebeck coefficient of NiCr/NiSi thin film thermocouple new intelligent bearing is 41.00 μV/℃, and the Seebeck coefficient of standard K thermocouple is 41.20 μV/℃. The new intelligent bearing has high sensitivity and stability, and can achieve fast response and accurate measurement. Finally, this paper summarizes the research results, and looks forward to the future research direction.

15:15-15:30
AA24-272E

Aerodynamics Performance Evaluation for New Twist Angle Design Axial Fan

Thanate Sangsawangmatum

King Mongkut's University of Technology North Bangkok, Thailand

Abstract: Axial fans are the most efficient air handling machines used in various industries. In contrast to centrifugal fans, axial fan blades rotate through the liquid to transfer their kinetic energy. With an inline air flow direction, the geometric design of the axial fan blade is suitable for machines with low system resistance and higher mass flow rates. Diameter ratio (outer diameter / hub diameter) and fan rotating speed are commonly used to determine design parameters and adjust aerodynamic performance. The differential pressure and mass flow rate of the fans can be significantly impacted by the angle of attack of the blade. The focus of this study is to evaluate the aerodynamic performance of axial flow fans using numerical methods. The main focus of interest is the difference in angle of twist in the three impeller models. By utilizing Computational Fluid Dynamics (CFD), the three-dimensional velocity and pressure distribution within the control volume will be shown. The numerical solutions for each case are shown along with the velocity vector and pressure distribution. Significant flow separation, flow fluctuation, and the creation of turbulence regions are shown. It is evident that decreasing the twist angle has become an alternative way to decrease the risk of stalling and enhance aerodynamic efficiency.

Session 2

Session 2- Image Based Intelligent Control System and Application
Chairperson: Prof. Tai Yan Kam, National Yang Ming Chiao Tung University, Taiwan

Time: 14:00-15:45, Mar. 9th, 2024	Room: CPD 3.24-3F, The Jockey Club Tower

*Note: The schedule of each presentation is for reference only. Authors are required to attend the whole session, in case there may be some changes on conference day. Please join in the room 5-10 minutes earlier.

14:00-14:15
AA24-276-A

Digital Dental Implanting Surgery: Assisted by Surgical Guide to Robot

Yunfeng Liu, Tianshu Kan, Xiangyu Zhou, Kangjie Cheng, Russell Wang, Fudong Zhu
Zhejiang University of Technology, China

Abstract: Replacing missing dentitions with dental implants has become a standard care for partially and completely edentulous patients in many situations. Accompanying techniques including 3D modelling of tissues, surgical planning, medical 3D printing used in clinic, surgical guide has been widely used in dental implant surgery for place site preparation, and in recent years, the technology in dental implant surgery has gone forward much steps, like the robot using for drilling. In this presentation, the guided dental implant technology will be reviewed, including the planning for dental implant placement, surgical guide design and printing, and clinical cases, then a human-robotic collaborative implant system (HRCDIS) will be introduced in detail, which is based on a zero-force hand-guiding concept and a operational task management workflow that can achieve highly accurate and stable osteotomy drilling based on a surgeon's decision and robotic arm movements during implant surgery robot.

14:15-14:30
AA24-218E

Pneumatically Operated Tendril-based Soft Hyper- Redundant Robotic Gripper

Shubhashis Sanyal, Anuj Kumar Shukla, Hrishi Sharad Pinjan, Piyush Tailor, Pyla Pavan Kumar, Suman Saurav, Surjeet Kumar Bhargav
National Institute of Technology Raipur, India

Abstract: The present work aims to design a soft, hyper redundant robotic gripper inspired by natural tendrils. The development of automation also requires extensive study in the field of biomimetic robotics. Most robotic systems are generally built using traditional rigid materials, such as hard plastics and metals. Building precise robotic systems requires a combination of rigid components to be joined at discrete joints. However, designing a robotic system inspired by natural systems consisting of continuous deformable materials should be equivalent to rigid robotic systems or even surpass their functionality. Soft and hyper redundant robotic grippers possess almost infinite degrees of freedom (DOF) and high kinematic redundancy levels. In the present work, a soft robotic gripper is proposed, inspired by plant tendrilsthat deform helically to hold the object on actuation. The work describes the initial design, material selection, method, important design parameters, an actuation mechanism, payload calculations and the simulation and analysis of the soft gripper. Such studies will be useful to industries and researchers in automation and biomimetic robotic systems.

14:30-14:45
AA24-214

MSA-GAN: A Novel Method for Inpainting EBSD Image Via Cellular Automation and Deep Learning

Baiyang Zheng, Jiongran Wen, Chengwei Fei
Fudan University, China

Abstract: Electron backscatter diffraction (EBSD) is an important technique for analyzing the

microstructure of materials. Unfortunately, EBSD images obtained by experimental means often suffer from different types of information loss, which affect the subsequent experimental analysis. Our study aims to study an EBSD image restoration method based on deep learning, which can solve the problem of various defects in EBSD imaging process. This paper proposes MSA-GAN: A multi-scale image restoration method based on generative adversarial networks (GAN) and feature pyramids (ASPP). To construct a dataset for training the model, a mask generation method based on cellular automata is proposed to simulate the information loss in EBSD images. The experimental results show that the MSA-GAN method can effectively restore large, medium and small types of defects in EBSD images, and achieve better results than other restoration methods, improving the quality and accuracy of the digital microstructure images. Our study provides a new technical means for the analysis of material microstructures, which has important theoretical and practical value.

Improvement Of Damage Identification in GFRP Plates Using Self-Heating Based Vibrothermography and Image Processing

Andrzej Katunin, Jafar Amraei, Krzysztof Lis, Dominik Wachla

Silesian University of Technology, Poland

14:45-15:00
AA24-217

Abstract: Self-heating based vibrothermography (SHVT) is the non-destructive testing technique developed by the authors, which does not require external heat excitation. Thermal excitation is performed using viscoelastic heating induced by resonant vibration of a tested polymeric composite structure. This is especially useful in cases where direct thermal excitation cannot be applied. In this study, the authors implemented the SHVT technique for two-dimensional plate-like structures with simulated damage, which allowed initial detection of damage. Advanced image processing methods make it possible to significantly enhance the detectability of damage compared to the raw thermographic images acquired during inspection. The analysis of applied image processing methods allowed analysing the increase in damage detectability and selecting the most effective ones to achieve the best improvement of raw thermograms. The results of this study may find application in the inspection of polymeric composite components, especially in aircraft industry, where timely detection of damage is crucial for ensuring structural integrity and safety.

A Frequency Swept Interferometer (FIS) Based Sensing System for Mega Satellite Constellation

Yifei Jiang, Zhong Chao, Wanxie He, Wang Wenyan, Shufan Wu, Qiankun Mo

Shanghai Jiaotong University, China

15:00-15:15
AA24-249

Abstract: With the rapid developments of communication technologies, non-terrestrial-network (NTN) is one of the most important technologies. Mega satellite constellation is the baseline of the NTN technologies. Unfortunately, as the density of satellite deployment, the risk of collisions between satellites also increases significantly. Therefore, sensing technology is an important solution to avoid collisions within constellation. In this article, a sensing system for satellite constellation is proposed. It contains multiple subsystems working together to ensure measurement accuracy. An accurate laser measurement based on frequency swept interferometer (FIS) is the core of the sensing system. With a ranging distance of a few hundred meters, the specific FSI ranger can reach microns level accuracy in repeating experiments. Those results guarantee the well performance of the sensing system.

Industrial Air Purifiers: CFD Investigation for Optimized Duct Design for Noise Reduction and Performance Enhancement

Anuj Kumar Shukla, Dinesh Babu, Sameer Dubey

National Institute of Technology Raipur, India

15:15-15:30
AA24-253E

Abstract: This research investigates into the critical intersection of fluid dynamics and noise generation within industrial air purifier ducts. As industrialization escalates, so does the concern for

environmental challenges and air pollution. Industrial air purifiers, designed to combat airborne contaminants, play a pivotal role in fostering cleaner and healthier industrial environments. However, the accompanying noise from essential components poses challenges for worker well-being and operational efficiency. Utilizing Computational Fluid Dynamics (CFD) simulations, our investigation systematically explores the impact of duct geometry on fluid dynamics, turbulence, and noise generation. Validation against experimental data ensures the accuracy of our numerical model. The deliberate variations in duct design across five models, coupled with subsequent simulations for four additional designs, reveal Design 5 as a successful contender in achieving noise reduction objectives. Comparative analyses of outlet velocities, inlet pressures, and sound levels provide actionable insights for engineers and manufacturers. This research not only advances our understanding of duct geometry's role in noise generation but also paves the way for quieter and more efficient industrial air purifiers. The optimized designs contribute to creating industrial environments that prioritize both workplace well-being and environmental sustainability.

15:30-15:45
AA24-259

Geometry Modelling of Solar UAV: Considerations and Guidelines for Design and Analysis

Hemza Layachi, Mohamed amine Bennaceur
Algerian Space Agency, ALGERIE

Abstract: This paper describes a methodology of the geometry analysis of a solar UAV in order to satisfy energy flight requirements by the integration of PV panels. It is shown that the surface of an UAV's wing has a direct relation to the structural weight. Since aerospace industry relay on weight saving concepts in order to optimize the energy usage, this paper shows the importance of an optimized selection of such geometry parameters in order to satisfy both concepts.

Session 3

Session 3- Avionics Systems and Wing Aerodynamic Analysis
Chairperson: Asst. Prof. (Dr.) Zhihui Liu, Tsinghua University, China

Time: 16:15-18:00, Mar. 9th, 2024	Room: CPD 3.21-3F, The Jockey Club Tower

*Note: The schedule of each presentation is for reference only. Authors are required to attend the whole session, in case there may be some changes on conference day. Please join in the room 5-10 minutes earlier.

16:15-16:30
AA24-201-E

Overview Of Research Status and Key Technologies of Bionic Flapping Wing Aircraft

Yubo Zhang
Northwestern Polytechnical University, China

Abstract: The design of bionic flapping wing aircraft based on the aerodynamic characteristics and flapping mode of birds and insects has obvious advantages at low Reynolds number, which is also the defect of ordinary fixed wing and rotorcraft. Among birds, hummingbirds can hover, fly forward and fly backward. Therefore, hummingbird-like aircraft plays a very important role in military and other fields. While satisfying the flight performance of hummingbirds, it has better concealment ability. In this paper, the research progress and key technologies of bionic flapping-wing aircraft are summarized, including bird flight mechanism research and design research of bionic hummingbird flapping-wing aircraft. The key mechanisms such as delayed stall mechanism, added mass effect and wake capture mechanism are mainly introduced. The design of bionic flapping-wing aircraft is summarized, and the main bottleneck problems and development trends of its application are put forward.

16:30-16:45
AA24-204-A

Experimental Investigation on Aerodynamic Performance of a Contra-rotor System

Jun Xiao
Nanjing University of Aeronautics and Astronautics, China

Abstract: With the launch of the "Ingenuity" helicopter, the speed of Mars exploration has become more efficient. The unique environment of Mars (low pressure, low density, and low temperature) causes rotorcraft to face a common situation: the low Reynolds number - high Mach number aerodynamics. The current study focuses on the aerodynamic performance of a series rotor blades under low-pressure and -density testing condition.
Firstly, the optimization of two-dimensional airfoils is carried out and its use as a basic configuration to design four sets of three-dimensional rotors. Secondly, the components of the experimental force measuring system are introduced. An experimental study of the APC 9*6E propeller in its hovering mode was undertaken as part of an effort to understand the acquisition accuracy of the force balance system. The experimental error is within 5 %, which proves that the accuracy of the force measuring platform meets the experimental requirements. Finally, rotors in single- and contra-rotating configurations are all tested. and the results are analyzed. The numerical simulations are also taken at the design conditions for the purposes of results comparison.

16:45-17:00
AA24-245-A

Unmanned Aerial Vehicle with Self-Structural Integrity Detection Capability

Tai Yan Kam
National Yang Ming Chiao Tung University, Taiwan

Abstract: Unmanned aerial vehicles (UAVs) have the potential to be used to perform difficult and complicated tasks such as performing damage inspection and maintenance of the composite wind blades of offshore wind turbines. The use of unmanned aerial vehicles (UAVs) to perform such task may reduce the high cost as well as the risk encountered in the current practice of sending inspectors to work at the wind blades. However, if an unreliable UAV is used to do the inspection work, an unexpected failure of the UAV may cause damages to the wind turbine. In this paper, an automatic structural integrity monitoring technique using the measured vibration data is developed for enhancing the reliability of UAVs. The proposed technique consists of three parts, namely, structural failure mode analysis, vibration data measurement for damage identification, and the development of an automatic structural integrity monitoring system for unexpected failure prevention. In the structural failure mode analysis, the finite element method is used to study the vibration characteristics of the UAV structure with different types of damages such as material cracking and connector failure. The effects of failure location and severity on the reduction of natural frequencies are investigated to produce results for establishing a damage identification procedure. In the vibration testing, the vibration data of the damaged UAV structure are measured for damage identification and verification of the theoretical modeling. The vibration of the UAV structure induced by the rotation of the rotor-blades are measured in both time and frequency domains. The vibration characteristics such as the maximum acceleration, the maximum amplitude, and natural frequencies of the damaged UAV structure are extracted from the vibration data. Based on the attained theoretical and experimental vibration characteristics, a criterion is then established for damaged detection. The proposed damage identification/detection criterion is then used to construct the automatic structural integrity monitoring system which can provide early warning to prevent the UAV structural failure from occurring. The technique developed herein can not only help enhance the UAV reliability but also extend its applications to the health monitoring of aerospace, wind power, and mechanical systems.

17:00-17:15
AA24-252-A

Heat Transfer Enhancement for Circulating Flow of Nanofluids Within Rectangular Enclosure Using Particle Tracking Method

Adel E. Alshayji
Kuwait University, Kuwait

Abstract: Due to wide applications of using nanofluids in thermal engineering system, and the significant enhancement of heat transfer when using nanofluids in comparison to pure base fluid as reported in the literatures, Investigating free convection across a square enclosure participated by nanofluids has been investigated numerically as shown in figure (1). This study focus on the effect of changing nanoparticles volume fraction, for several nanoparticles materials, on the heat transfer across the enclosure using particle tracking method and variable nanofluids properties with temperature along with variable particles temperature. This method enables us to express more realistic results and test this system at very high temperature and at wide range of Rayleigh number. Enhancements of heat transfer have numerically discovered and expressed in terms of averaged Nusselt number versus the nanoparticles volume fraction parameterized in enclosed geometry. Our study may benefit future investigations that desire to understand heat transfer mechanisms of nanofluids in high temperature range and to optimize heat-transfer characteristics for various thermal systems.

17:15-17:30
AA24-260

LAVIT (LAVavatory system for Interplanetary Travels) for NASA's Artemis Program

Riya Karmakar, Bhardwaj Shastri, Ubol Choomjinda, **Arvind Mukundan**, Hsiang-Chen Wang
National Chung Cheng University, Taiwan

Abstract: NASA's Artemis program aims to land on the Moon by 2024. Returning to the Moon will establish a base for future crewed Mars missions. Many efforts are underway to provide astronauts with equipment, housing, and other assistance as the prospect of returning to the Moon. Mass reduction, volume reduction, energy efficiency improvements, and operational optimization are the goals. Astronauts will urinate and defecate in microgravity and lunar gravity after eating and drinking. During their time inside the spacecraft and outside of their spacesuits, astronauts will require a toilet that possesses equivalent functionalities to that found on Earth. Therefore, in this study, a a complete lavavatory system for interplanetary travels have been developed and designed.

17:30-17:45
AA24-264

Enhancing VTOL Performance: Shrouded Rotor BLDC Motor Model and Validation

Abdallah Dayhoum, Mohamed Etewa, Alex Ramirez-Serrano, Robert Martinuzzi
University of Calgary, Canada

Abstract: One prominent area of current research interest, driven by a multitude of factors and considerations, centers around drone technology. A primary challenge currently faced in the realm of small-scale Unmanned Aerial Vehicles (UAVs) is the increasing demand for increased power coupled with the constraint of limited flight duration provided by available battery technology. These vehicles fall into two overarching categories based on the presence or absence of shrouding around their rotor(s). Shrouded rotors play a pivotal role in augmenting aerodynamic performance by enhancing thrust while mitigating blade-tip vortex losses and numerous other aspects that are not presented in open rotors. Although such characteristics contribute to an expanded effective rotor diameter and optimized airflow within the shroud. There are numerous aspects related to power, shroud and rotor characterization, etc. that need to be understood before shrouded rotors are commonly used. This paper presents the implementation of an effective mathematical model for Brushless Direct Current (BLDC) motors, specifically tailored for application in conjunction with shrouded rotors aimed at enhancing thrust and reducing power consumption. The proposed model serves to predict the performance characteristics of the utilized motor within the context of the specified shrouded rotor combination. In order to identify the effects of the induced load torque on the rotor's dynamic response, a methodical analysis is conducted on the numerical simulation of the proposed model. The results are experimentally verified for hover flying in a case study of a scalable and highly maneuverable vertical takeoff and landing aircraft developed for operations in highly confined spaces. The adoption of this modeling technique is anticipated to significantly streamline the shrouded rotor combination design and selection process, particularly in the selection of an appropriate motor.

17:45-18:00
AA24-261

LULAD (LUnar LAva tube Discoverer) Instrument for NASA's Commercial Lunar Payload Services (CLPS) Program

Riya Karmakar, Bhardwaj Shastri, Ubol Choomjinda, **Arvind Mukundan**, Hsiang-Chen Wang
National Chung Cheng University, Taiwan

Abstract: NASA's latest lunar exploration program is Artemis. In-situ Resource Utilization (ISRU) will become more important as human space travel moves toward a lunar presence. CLPS helps the Artemis Program develop and use compact autonomous landers and rovers. A series of lunar micro-rovers will be launched in the coming years to collect data and conduct scientific research on the moon. Subterranean lava tubes on celestial bodies are promising habitats for human expansion beyond Earth. Due to its lack of atmosphere, the moon is vulnerable to meteoroid impacts and cosmic and solar particle radiation. These factors make surface lunar base construction difficult. Subterranean lava tubes can provide safety due to the many strata of lava basalt that form a thick roof several meters thick. This paper will discuss the design of the LUnar LAva tube Discoverer (LULAD) instrument, which aims to explore regions of interest and possibly find candidate lava tubes on the moon.

Session 4

Session 4 - Aircraft Engine Model and Hybrid Power System
Chairperson: Dr. Chengwei Fei, Fudan University, China

Time: 16:15-17:45, Mar.9th, 2024	Venue: Room: CPD 3.24-3F, The Jockey Club Tower

*Note: The schedule of each presentation is for reference only. Authors are required to attend the whole session, in case there may be some changes on conference day. Please join in the room 5-10 minutes earlier.

16:15-16:30
AA24-206

Gas Dynamic Optimisation of The Working Process of a Single-Stage Axial Turbine with A Deflector Inside

Grigorii Popov, I A Kudryashov, S A Melnikov
Samara National Research University, Russia

Abstract: The paper presents the optimisation results of the working process of a single-stage axial turbine in order to increase its efficiency. During the optimisation it was required to preserve the design of the original turbine as much as possible. To solve this problem, a scheme of parameterisation of turbine blades and turbine flow path contours was developed taking into account design and technological constraints. The stator blade of the turbine had a deflector. To control the possibility of deflector placement, a special programme was developed that automatically tracks the spatial position of the stator blade sections. A post-processing programme was developed to control the flow parameters at the turbine outlet by height. The optimisation criteria were efficiency and the value of deviation of the turbine outlet angle by height from the initial one. The constraints were the working fluid flow rate and the total pressure ratio in the turbine. The problem was solved in several steps with different varying variables. As a result of solving the problem, the turbine efficiency was increased by 0.9 %.

16:30-16:45
AA24-225

Explicit Calculation Method for Heat Exchanger Considering Variable Physical Property Treatment

Zhiwei Liu, Qihang Liu, Jie Wen, Bensi Dong
Beihang University, China

Abstract: This work presents a heat exchanger calculation method characterized by the explicit temperature solution (ETS) for the working medium. This method is derived for both parallel-flow and counter-flow patterns based on the traditional LMTD method. As the temperature distribution is given in an explicit form related to the mixing temperature, the heat transfer performance of heat exchangers can be solved without iterations, improving the efficiency of heat exchanger design. Considering the practical engineering application, the influence of variable physical property is discussed. The temperature distributions of the reference temperature method and the integral method (whole length) are compared with the accurate distribution of the adaptive-grid method (segmented). Results indicate that the temperature distribution obtained by the integral method highly coincides with the accurate one, showing a relative error of only 0.36 %. The proposed ETS method with integral physical property treatment is an efficient and accurate way for heat exchanger design.

End-To-End Design of Multistage High-Pressure Axial Compressor for A Promising Aviation Gas Turbine Engine

Evgenii Goriachkin, I A Kudryashov
Samara National Research University, Russia

16:45-17:00
AA24-208

Abstract: The paper describes the results of an end-to-end design of a multistage high-pressure axial compressor for a promising aircraft engine. The design included the steps of initial design and detailed fine-tuning of the working process using three-dimensional numerical modelling. The initial design included the steps of flow path shape determination, design thermodynamic calculation, and one-dimensional gas dynamic calculation at the mid-diameter and height of the flow path. Statistical processing of parameters of known compressors was used to select parameters during the initial compressor design. The initial design was performed for several compressor configurations differing in the main design parameters: type of flow path, number of stages, speed and others. Three-dimensional modelling and comprehensive comparison of working process parameters were performed for the most promising of the obtained variants. On its basis, the most promising variant was selected, for which the subsequent refinement using three-dimensional numerical modelling was carried out. As a result of compressor design, all required parameters were achieved.

Linked Multidisciplinary Optimisation of a Twin-Shaft Turbine of a Promising Turboshaft Engine

Grigorii Popov, Vasiliy Zubanov, Oleg Baturin, Anastasia Korneeva
Samara National Research University, Russia

17:00-17:15
AA24-207

Abstract: The paper presents the results of the linked multidisciplinary optimisation of a single-stage turbine of a compressor and a single-stage free turbine of a promising turboshaft engine. In the process of optimisation, gas dynamic, strength, design and technological constraints were taken into account. Calculation of gas dynamic parameters was performed using 3D CFD modelling. Calculation of strength parameters was performed using 3D CSM modelling. Analysis of geometrical parameters of blade profiles was performed using in-house developed programmes. The geometrical parameters of the blade profiles were used as varied parameters. The total number of varying parameters was 194. As a result of solving the optimisation task, a turbine variant was found with the compressor turbine efficiency 0.32 % higher than that of the original turbine, as well as with the efficiency of the free turbine 0.7 % higher than that of the original one. At the same time the fulfilment of all constraints is ensured.

Aerodynamic Investigation of Shrouded Rotors with Dual Exit Channels

Abdallah Dayhoum, Alejandro Ramirez-Serrano, Robert Martinuzzi
University of Calgary, Canada

17:15-17:30
AA24-256

Abstract: The escalating demand for rotary-wing aerial vehicles capable of achieving both high forward speeds and reliable hover performance has become imperative across various sectors. These vehicles can be broadly categorized based on whether their rotor(s) is (are) shrouded or not. Shrouded rotors enhance aerodynamic performance by improving thrust and eliminating blade-tip vortex/losses, among other factors. These aspects augment the effective diameter of the rotor and optimize airflow through the shroud. Consequently, a shrouded rotor produces a greater total thrust compared to an open rotor, under the same (ideal) power consumption. Furthermore, the induced velocity flow field of a shrouded rotor exhibits increased uniformity compared to an open rotor,

attributed to the shroud's presence, which mitigates power losses. This paper presents a parametric computational investigation centered on the hypothesis, that dividing the shroud exit channel into convergent inner and divergent outer channels would enhance flow uniformity, reducing power losses, and preventing airflow separation from the main shroud's inner walls. The validity of this hypothesized concept is demonstrated through extensive computational fluid dynamic (CFD) simulations. The paper includes a case analysis utilizing experimental data from a highly-maneuverable drone, named Navig8, equipped with a 9-inch shrouded propeller where various shrouded configurations are examined using Computational Fluid Dynamics. Results typically show an increase in total thrust with the incorporation of an inner shroud for a given power.

17:30-17:45
AA24-209

Regression Equations for Estimating Axial Compressor Flow Path Dimensions at The First Design Steps

Oleg Baturin, E D Gataullina, **Evgenii Goriachkin**, Vasiliy Zubanov
Samara National Research University, Russia

Abstract: The article presents the results of a study aimed at obtaining dependencies (formulas) that can be used at the first steps of design of axial compressors of gas turbine engines to estimate their axial dimensions. The currently available recommendations are of a general nature and their application allows obtaining results that differ from each other under different interpretations by more than 30%. The authors have collected statistics on more than 20 modern gas turbine engines and on the basis of its regression analysis have obtained a package of dependencies that will allow obtaining a flow path shape approximating to the final one at the first steps of design. The obtained formulas are based on a larger number of initial data than existing today. Using the obtained formulas will require less refinement in the next steps, which will reduce the iteration number during the design and save time and costs.

Session 5

Session 5- Modern Machinery and Control Technology
Chairperson:

Time: 10:00-11:45, Mar. 10th, 2024 | Zoom Link: https://us02web.zoom.us/j/87478396462

*Note: The schedule of each presentation is for reference only. Authors are required to attend the whole session, in case there may be some changes on conference day. Please join in the room 5-10 minutes earlier.

10:00-10:15
AA24-210

Gradient-Based Aerodynamic Shape Optimization Using A Discrete Adjoint Approach On A Graphics Processing Unit

Liu Yang, Jian Yang
MetaX Integrated Circuits (Shanghai) Co., Ltd, China

Abstract: This paper presents a gradient-based aerodynamic shape optimization framework that utilizes a Graphics Processing Unit (GPU) for solving both flow and adjoint equations. It is built based on a GPU-accelerated flow solver that has been developed previously. Hence, the focus of this work is on how to solve the adjoint equations on the GPU and subsequently compute the gradients. The adjoint equations are right-preconditioned by a block Incomplete Lower Upper (ILU) preconditioner and solved by a restarted Generalized Minimum Residual (GMRES) method. The exact residual Jacobian matrix in the adjoint equations is computed using finite difference and a distance-2 graph coloring algorithm. With the adjoint-based gradients, the steepest descent method with momentum is employed for constrained aerodynamic shape optimization of a wing-body configuration at a transonic flow condition.

10:15-10:30
AA24-211

A Proposal of Drilling Unit for Robotic Machining

Yasuo Kondo, Jho Arimura, Tom Oh-hori
Yamagata University, Japan

Abstract: In the assembly of large aircraft, drilling is often performed onsite after components are assembled, and many holes are still drilled by manual labor. In this unusual condition, it is difficult to apply conventional CNC machining. The authors have been proposing soft machining, a machining method that copies human drilling, as a machining method suitable for robotic drilling. In soft machining, thrust force is controlled to be smaller than that in CNC machining, and hole widening and burrs are less likely to be generated. In addition, vibration can be controlled by optimizing arm layout and drill shape. A twist drill with a 135° tip angle that was resharpened to a 115° tip angle at the center of the drill showed high performance in suppressing vibration. These facts indicate that soft machining can be applied to robotic drilling.

10:30-10:45
AA24-269E

Design and Application of Micro-vibration Test Platform for Control Moment Gyroscope of Space Station

Xie Yicun, Jiang Qiang, Wu Yao, Shen Zhiqiang, Liu Chuang, Li Dong , Liu Kexin, Li Xinying
Beijing Institute of Satellite Environmental Engineering, China

Abstract: In order to obtain the disturbance force and torque of large control moment gyroscopes used in China space station, a calculation method of the resultant force and moment at the product center of mass was studied. A disturbance force testing system for large control moment gyroscopes

was designed, and structural modal testing and disturbance force and torque testing were carried out on the rigid installation and isolator installation states of the control moment gyroscopes. By analyzing the root mean square values of disturbance force and torque, as well as the isolation efficiency at the operating frequency of the control torque gyroscope, it can be concluded that the isolator has a good isolation effect.

10:45-11:00
AA24-234E

Research Status and Development Trend of Precision Cutting Technology

Shan Li, Aldrin D. Calderon
Zhengzhou Business University, China; MAPUA University, Philiphines

Abstract: Precision cutting technology plays an important role in modern manufacturing, which providing key solutions for the production of high-precision, high-quality parts. Firstly, on the basis of reading a lot of relevant papers, the classification and advantages of precision cutting technology are summarized in this paper, and then the research status of cutting force control, tool wear, nano cutting, model simulation and optimization and green sustainable development are summarized and analyzed. On this basis, the problems existing in the current precision cutting technology are pointed out, and the future development trend is predicted.

11:00-11:15
AA24-275E

Separation Schemes and Dynamic Analyses on Parallel Stage Separation of Launch Vehicles

Yahan Xu, Liang Chen, Guolian Song
Beijing Institute of Astronautical Systems Engineering, China

Abstract: For launch vehicles with multiple stages, the stage separation is critical, which directly determines the success of the launch mission. In this article, a launch vehicle with a parallel second stage is taken as the research subject. A basic separation scheme including separation force and separation direction is proposed. Then, separation dynamic analyses are performed through ADAMS. The trajectory and attitude during the separation have been obtained. On the one hand, the aerodynamic forces help to increase distance between stages. On the other hand, aerodynamic moments acting on the second stage cause high pitch velocity. Separation procedure can be divided into three different time duration including interference duration, escaping from interference duration and free stream duration. The research conducted in this paper will provide guidance for the design of separation systems of the launch vehicle.

11:15-11:30
AA24-235

The Stiffness of Elastomeric Diaphragm in Pneumatic Springs

Yumei Bai, Jixing Che, Mingkai Wu, Jiulin Wu, Wei Jiang
Huazhong University of Science and Technology, China

Abstract: The design of a vibration isolation table using pneumatic springs requires an accurate mathematical model of the pneumatic spring. An experimental investigation of the validity of the existing model has been performed, and the results showed that neglecting the effect of the diaphragm on isolator response results in a significant error between the predicted and observed behavior. This paper develops the modifications to the standard pneumatic spring model that incorporate the effects of the diaphragm. A theoretical model for diaphragm stiffness is presented. The model equates the inner and outer rings of the diaphragm into two segments of composite material subjected to unidirectional stretching. The elastic modulus and stiffness of each part of anisotropic materials were obtained using the theory of composite mechanics, combined with the working conditions of the diaphragm. Finally, the dynamic stiffness experimental platform was built to verify the theoretical model. The result indicates that considering the stiffness of elastomeric diaphragm, the error is reduced from 14.75% to 3.83%.

11:30-11:45
AA24-270E

Temperature Field Analysis and Control of Vacuum Ultra-High Speed Angular Contact Ball Bearings

Baoli cui, Yongjun Cheng, Pengyang Jia, Jiachang Liu, Zhihui Liu, Bi Wang, Jiakang Yao, Jun Ye, Zixi Wang, Jiaying Tang
Tsinghua University, China

Abstract: In order to explore the distribution of the bearing temperature field under vacuum ultra-high speed, and put forward a good temperature control method, this paper through the use of local method of bearing temperature analysis of various parts of the calculation, the use of ANSYS finite element analysis method to establish the bearing simulation model, and in the vacuum ultra-high-speed motor experimental platform to test to prove that the data show that: the temperature between the rollers and the inner and outer races is higher, and with the increase in rotational speed, the temperature continues to rise, in the bearings speed up to the setting of the speed for a period of time the temperature will continue to rise, and ultimately reached the steady state temperature; through the setting of the structure of the water jacket on the bearing temperature control effect is remarkable.

Session 6

Session 6- Control Model and Simulation in Aviation Systems
Chairperson:

Time: 13:00-15:00, Mar.10th, 2024	Zoom Link: https://us02web.zoom.us/j/87478396462

*Note: The schedule of each presentation is for reference only. Authors are required to attend the whole session, in case there may be some changes on conference day. Please join in the room 5-10 minutes earlier.

13:00-13:15
AA24-241

Design Of Improving Volumetric Efficiency of Waverider Based on Area Rule

Haoyuan Ma, Dehua Zhu, Hao Lou
China Academy of Aerospace Aerodynamics, China

Abstract: In terms of waverider's aerodynamic performance degradation due to the design of increasing volume in engineering, it's a solution to improve the design operations referring to area rule. With theory analysis and numerical simulation, the application of supersonic area rule at hypersonic speed was studied; an improved shape modification method based on area rule was developed and validated. The research results could support the design of improving volumetric efficiency of waverider and showed as follows: Object is supposed to be slender enough to ensure supersonic area rule's application accuracy at hypersonic speed, which indicates the challenge to apply supersonic area rule to practical hypersonic vehicle due to unsatisfactory geometrical character; referring to some scholars' development of area rule at hypersonic speed, improved shape modification method based on transonic area rule was developed and the influence of object's geometrical character on drag reduction at hypersonic speed was studied; Applying the improved shape modification method, the modified combination of volume body and waverider had the drag reduced by 4% and volume increased by 31%, volumetric efficiency increased by 5%.

13:15-13:30
AA24-244

Tanker Remote Vision System： Review And Key Technologies

Chao Zhang, Zhenkai Fan, Yuxuan Liu, Aobo Shi
Xi'an Jiaotong University, China; State Key Laboratory for Strength and Vibration of Mechanical Structures, China

Abstract: The tanker remote vision system (RVS), supporting boomer with adequate view and information for air-to-air refueling operations, has become a must for modern tankers and foundation of autonomous aerial refueling. The application, composition, and development of the visual systems of KC-46A and A-330MRTT aircraft are summarized. Key technologies for tanker visual systems are proposed, including high-definition cameras, multi-sensor data fusion technology, 3D virtual precise imaging technology, and all-weather high-precision target data perception technology. The relevant content serves as a reference for the research and development of tanker remote vision system.

13:30-13:45
AA24-263

Design and Research on the Refit Scheme for Natural Icing Flight Test of Large Civil Aircraft

Jia Liu, Binbin Zhao, Feng Zhou, Qiaotian Dong, Yibo Kang
Shanghai Aircraft Design and Research Institute, China

Abstract: The natural icing flight test is an important compliance method for flight in icing conditions defined in CCAR25-R4 Appendix C, which is high-risk, difficult, and requires a large number of specialized refits. This article analyses the main refit requirements based on the natural icing flight test verification tasks of large civil aircraft, including cloud combination probe, cameras, painting, ice scales, etc. The refit Scheme design includes: using the FENSAP-ICE icing calculation software, designing the installation position and height of the cloud combination probe; The quantity, location, and functional design of cameras; The scope, colour matching, and scale design of painting; The quantity, layout, priority definition, scale, angle, colour matching design of ice scales. The refit scheme designed in this article can provide reference for the natural icing test flight refit of large civil aircraft.

13:45-14:00
AA24-268E

A Hybrid Algorithm for Predicting Head Related Transfer Function based on Physiological Parameters

Dongdong Lu, Jianbin Zhu, Zhiqiang Shen, Chuang Liu, Qi Xin
Beijing Institute of Spacecraft Environment Engineering, China

Abstract: The Head Related Transfer Function (HRTF) characterizes the interaction between sound and the physiological structure of the listener, therefore, HRTFs have personalized characteristics. This paper proposes a hybrid algorithm for predicting HRTFs based on anthropometric parameters. This algorithm reduces the dimensionality of physiological parameters and HRTF, and then constructs a regression model between physiological parameters and HRTF. Firstly, principal component analysis is used to reduce the dimensionality of HRTF, followed by sparse principal component analysis to reduce the dimensionality of measured physiological parameters. Finally, a prediction model from physiological parameters to principal component coefficients is constructed through least squares regression. The predicted results were analyzed with spectral distortion. The result indicates that this prediction method can effectively predict HRTF.

14:00-14:15
AA24-271E

Image Matching-Based Visual-Inertial Integrated Navigation for UAV in GNSS-Denied Environments

Tian Qi Huang, Y B Zhou, B H Zhang
University of Chinese Academy of Sciences, China

Abstract: For unmanned aerial vehicle (UAV) navigation in global satellite navigation system (GNSS)-denied environments, an image matching-based visual-inertial integrated navigation system is proposed. Deep learning-based methods are used for image matching to address the challenges of multi-modal image matching. A feature mismatch removal method using reference visual data and inertial navigation prior pose is proposed to improve the accuracy and robustness of image matching. Error-state Kalman filtering (ESKF) is applied to fuse the outputs of visual navigation and inertial navigation and calibrate the inertial navigation system. In addition, an image mismatch detection method based on Kalman innovation detection is applied to avoid severe errors caused by image mismatch. Finally, the proposed integrated navigation system is validated by Airsim simulation and a public dataset.

14:15-14:30
AA24-215

Docking Hybrid Propellant Rocket with Hierarchical Neuro-dynamic Learning in a 3D Simulated Environment

Sara Karim, Air Commodore (Retd) Md Abdus Salam, Dr. G.M. Jahangir Alam
Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU), Bangladesh

Abstract: The concept of rockets capable of autonomous landing has been a subject of theoretical discussion for the past century. However, it wasn't until 2014 that the successful execution of a vertical landing with thrust vectoring in an actual rocket was achieved for the first time. Our study has constructed a hierarchical Markov Decision Process (MDP) framework developed for vertical rocket landings. We break down the landing problem into distinct sub-challenges, specifically addressing velocity control with Neuro-dynamic Learning in a Simulated Environment. Our study offers a significant contribution to hierarchical MDP configuration that consistently accomplishes rocket landings within our predefined criteria, achieving a success rate of 91 per cent. The validity of our approach will be demonstrated through performance comparisons with an intent to employ Neuro-dynamic learning within a hierarchical Markov Decision Process (MDP) framework, operating within a 3D environment to resolve this challenge.

14:30-14:45
AA24-203

Unexpected Electrical Breakdown Characteristics and Protection of PPU in Space Electric Propulsion System

Beifei Sheng, **Siqiao Ge**, Shuo Jiang, Xuan Zhang, Fengping He, Kang Li
China Academy of Space Technology, China

Abstract: The application of fully electric propulsion satellites will increase the risk of low-pressure discharge in electric propulsion devices, especially ion thrusters, whose unexpected breakdown will directly affect the reliability of satellite applications. Existing on-orbit cases show that the unexpected breakdown occurred in the power processing unit (PPU) of the ion thruster during orbit change, which led to the failure of thruster. Therefore, this paper analyses the high-voltage components inside the PPU, and systematically discusses the PPU and its working environment, the control and protection technology of unexpected electrical breakdown of the electric propulsion system and its aerospace engineering. In this paper, we discuss the electric field intensity and discharge margin of components in the PPU under different conditions, and further propose a method for insulation evaluation based on partial discharge (PD) detection. The research results show that the discharge margin in the PPU is close to the lowest discharge voltage level of uniform electric field, so reasonable insulation protection measures should be taken against discharge under high voltage condition. Furthermore, we propose a feasibility analysis method based on PD insulation defect detection, which provides a basis for quantitative analysis and evaluation of component insulation design in PPU systems.

14:45-15:00
AA24-246E

Micro-Vibration Simulation of Laser Communication Satellite Subjected to The Disturbance of Momentum Wheels

Jie Zhang, Jiacong Yin, Sang Ye, Shengwei Pei, Yihong Wang
China Academy of Space Technology, China

Abstract: As the laser gradually replaces the microwave for satellite communication, micro-vibration environment of satellites in orbit become the key factor to keep laser link and communication quality. Due to the limited use of vibration suppression measures, micro-vibration simulation covering the whole frequency range up to 1000 Hz is required for laser communication satellites, which is inevitably more difficult than optical satellites focusing on low-frequency characteristics. This paper proposes an engineering algorithm that can quickly and efficiently simulate the micro-vibration environment of satellites within 1000Hz, and the simulation results are confirmed by experimental data.

One Day Tour

Time **09:00-19:00, March 10th, 2024 (Time Zone: GMT+8)**

Scheduling

09:00 Start from The University of Hong Kong → Wong Tai Sin Temple → Lunch → Avenue of Stars → The Star Ferry→ Golden Bauhinia Square → Famous Filming Location (Central-Mid-Levels Escalator and Walkway System & Pottinger Street) → Victoria Peak → 19:00 End at The University of Hong Kong

Fee **95 USD/690 RMB**

Including The Star Ferry tickets, Lunch (Table-surrounding style in Hong Kong restaurants)
Excluding All expenses required for activities outside the itinerary.

Service Language (Tour Guide) **English**

Minimum Number of Tourist Required **10 (Otherwise the one-day tour will be cancelled)**

Notice

1. Please be sure to bring your valid Exit-Entry Permit for Travelling to and from Hong Kong and Macao/Visa with you.
2. Please abide by the laws formulated by the government of the Hong Kong Special Administrative Region, and those who violate them will bear the consequences.
3. The scenic spots, meals and other arrangements in this tour shall be subject to the arrangement of the tour guide.
4. Tourists are requested to arrive at The University of Hong Kong at least 10 minutes in advance. (The bus leaves at 09:00. Please be there at 08:50 or earlier)

Highlights of the Tour

➢ **The famous temple [Wong Tai Sin Temple] (about 40 minutes)**

The only inland area in Hong Kong, the temples in the area are coexisting in tall buildings, coexisting Zen and noise, which is dazzling and has typical Hong Kong characteristics. The name of this area is coming Self -taught Wong Tai Sin, you can see his portrait in the Temple in the Sika Garden. The believers who came to pray for the prayer of God all year round, the incense in the temple is extremely prosperous;

➢ **New Creation [Avenue of Stars] (about 40 minutes)**

In 2019, the Avenue reopened. Through a refreshing design, it will show a vibrant seaside, providing citizens with a diversified leisure experience, and praising outstanding achievements in the local film industry have become a special tourist hotspot welcomed by local communities, industry, tourists, and filmmakers.

➢ **[Take the Star Ferry] (about 10 minutes)**

A century ago, the Star Ferry had begun to pick up passengers between Hong Kong Island and Kowloon Harbor. Take the Star Ferry to cross Victoria Harbor, reinserate the antique ferry, and enjoy the city's painting of the city from the ferry.

➢ **[Golden Bauhinia Square] [The Monument in Commemoration of the Return of Hong Kong to China] (Appearance) (about 20 minutes)**

On the square outside the exhibition center, there is a large sculpture called "Bauhinia Forever Blooming Forever", as the return commemorative congratulations from the Government of the People's Republic of China to the Hong Kong Special Administrative Region Government.

➢ **[Central-Mid-Levels Escalator and Walkway System] (about 15 minutes)**

The escalator in Central is about 800 meters long. Visitors are easy to ride, overlooking the scenery of the streets and alleys of Central!

➢ **[Pottinger Street] in the nostalgic characteristics of the old city (about 15 minutes)**

Pottinger Street named after the first Governor of the colonial era. Pottinger Street existed as early as the 1850s, and it is one of the oldest streets in Central. The stone -level design with unique style makes it here to become a Hong Kong movie and popular shooting location of TV series.

➢ **[Victoria Peak] (about 30 minutes)**

Victoria Peak is located in the northwestern part of Hong Kong Island. It is one of the landmarks of Hong Kong. From here, you can overlook Lantau Island, the panoramic view of Hong Kong, and see the skyscrapers and the charming scenery of Victoria Harbor nearby.

NOTE