INCAS
National Institute for Aerospace Research "Elie Carafoli"
(under the Aegis of The Romanian Academy)

10th edition of the International Conference of Aerospace Sciences

"AEROSPATIAL 2022"

Bucharest, Romania | 13-14 October 2022

Hybrid Conference

BOOK OF ABSTRACTS

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AEROSPATIAL 2022

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Agenda

Day 1 | Thursday, 13 October 2022

Time (CET)		Plenary ROOM 1 (Amphitheater "Elie Carafoli") Click to join the Hybrid Meeting
10:00	10:20	**Welcome and introduction** by the Workshop Chairman Dr. Eng. **Catalin NAE**, President & CEO, INCAS – National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania Dr. Eng. Fiz. **Mihail-Liviu COSEREANU**, Scientific director, INCAS – National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania Prof. Dr. Eng. **Daniel-Eugeniu CRUNTEANU**, Dean of Faculty of Aerospace Engineering, "POLITEHNICA" University of Bucharest, Romania Dr. Fiz. **Adriana STEFAN**, President of the Scientific Council of the INCAS – National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania
Invited Speakers **10:20 – 11.50**		**Chair: Catalin NAE** *(INCAS)*
10:20	10.50	**"A real application in gate assignment problems combining optimization, simulation, and delay prediction"** **Alejandro MURRIETA-MENDOZA*,** Roberto Salvador FELIX PATRON, Miguel MUJICA MOTA | Aviation Management Amsterdam University of Applied Sciences, Amsterdam, the Netherlands
10:50	11.20	**"Scaling of morphing structures: a case study on selected effects"** **Antonio CONCILIO*, Salvatore AMEDURI** | CIRA - the Italian Aerospace Research Centre, Italia
11:20	11:50	**"Hybrid manufacturing of thermoplastic composite structure"** **Konrad KOZACZUK***, Bartlomiej WASNIEWSKI, Wojciech KRAUZE | Lukasiewicz Research Network – Institute of Aviation, Center for Composite Technologies, Warsaw, Poland
11:50	12:50	**LUNCH**

ROOMs Session 13:00 – 15:00		ROOM 1 (Amf. "Elie Carafoli") Click to join the Hybrid Meeting	ROOM 2 (Materials and Tribology) Click to join the Hybrid Meeting ROOM 2	ROOM 3 (Corp B. et. 2) Click to join the Hybrid Meeting ROOM 3
Session Title		**Astronautics and Astrophysics**	**Materials and Structures**	**Experimental Investigations in Aerospace Sciences**
Session Chair(s)		**Constantin OLIVOTTO** *(INCAS)*	**Adriana STEFAN** *(INCAS)* **Viorel ANGHEL** *(UPB)*	**Cristian POSTOLACHE** *(IFIN-HH)* **Ioan URSU** *(INCAS)*
13:00	13:20	S3.1 **Relative Mechamical Movement of Bodies in Outer Space - the relative inertia** ***Sorin Stefan RADNEF****	S4.1 **FEM Applications of Catenary Type Structures** ***Viorel ANGHEL****, ***Ștefan SOROHAN*** *Daniel HODOR*	S.6.1 **On the evaluation of turbulence parameters in the wind tunnel** ***Daniela ENCIU****, *Ioan URSU,* *George TECUCEANU*
Session Title		**ATS and full Automation ATM**		
Session Chair(s)		**Constantin OLIVOTTO** *(INCAS)*		
13:20	13:40	S7.1 **Enhancing the performance of the Primary Surveillance Radar using Multilateration** ***Nicolae CONSTANTINESCU****, *Emil CONSTANTINESCU,* *Alina-Ioana CHIRA*	S4.2 **Experimental studies on grease performance during operating time** ***Alexandru Valentin RĂDULESCU****, *Irina RADULESCU*	S6.2 **Gamma irradiation facility for evaluation of space radiation effects on biological systems** ***Cristian POSTOLACHE****, *Andi Sebastian CUCOANES,* *Catalin Stelian TUTA,* *Gina MANDA*
Session Title		**Aerodynamics**		
Session Chair(s)		**Daniel-Eugeniu CRUNTEANU** *(UPB)* **Alexandru-Iulian ONEL** *(INCAS)*		
13:40	14:00	S1.1 **Active Flux Scheme for Time-Dependent, Viscous, Compressible Flows** ***Oliviu ȘUGAR-GABOR*** *(UK)*	S4.3 **Aspects regarding the load transmissibility on a squeeze film damper supported rotor** ***Laurentiu MORARU****	S6.3 **Opportunities at ELI-NP: Materials testing under the influence of high energy ionizing radiation** ***Andi Sebastian CUCOANES****, *Cristian POSTOLACHE,* *Ovidiu TESILEANU,* *Catalin Stelian TUTA,* *Gina MANDA*
14:00	14:20	S1.2 **Non-Intrusive Reduced-Order Model for Unsteady Fluid Flow and Fluid-Structure Interaction Problems** ***Oliviu ȘUGAR-GABOR*** *(UK),* *Daniel FAIRCHILD (UK)*	S4.4 **Lightweight reinforced thermoplastic materials for vacuum thermoformed encapsulation applications in unmanned aerial vehicles (UAVs)** ***Cristina-Elisabeta PELIN**** *Maria SONMEZ,* *George PELIN,* *George Cătălin CRISTEA,* *Adriana ȘTEFAN,* *George STOIAN,* *Mihail BOTAN,* Mihai GEORGESCU, Mihaela NITUICA, Maria Daniela STELESCU	S6.4 **Analysis of the effects of electrostatic field interaction with photovoltaic cells used to power a solar UAV** ***Andrei BUZDUGAN****, *Nicolae JULA*

14:20	**14:40**	S1.3 **Design and analysis of a morphing winglet based on a biomimetic mechanism with flexible composite skin: Application on the UAS-S45** ***Musavir BASHIR*** *(Ca),* *Simon Longtin-MARTEL (Ca),* *Ruxandra Mihaela BOTEZ* (Ca),* *Tony WONG (Ca)*	S4.5 **A (Historical) Review of Deployable Reflector Antennas for Space Applications** ***Bianca MOLDOVANU****	S6.5 **Experimental research of hydraulic cylinder with the built-in throttle for steering** ***Bogdan Adrian NICOLIN*,*** *Ilie NICOLIN*
14:40	**15.00**	S1.4 **Morphing Trailing Edge with Seamless Transition Flaps: A High-Fidelity Optimization Study** ***Mir Hossein NEGAHBAN*** *(Ca),* *Ruxandra Mihaela BOTEZ* (Ca)*	S4.6 **Microstructure, microhardness and thermal shock behavior of laser cladding MCrAlY based alloy on Nimonic 90 substrate** ***Mihail BOTAN*,*** *Adriana STEFAN,* *Victor MANOLIU,* *Gheorghe IONESCU,* *George Catalin CRISTEA*	S6.6 **Experimental Investigations of Free Air Turbulence Using Low Mass, Data Linked UAVs** ***Alexandru Marius PANAIT****
15:00	**15:10**	**Break**		
Time (CET)		**Plenary ROOM 1 (Amphitheater "Elie Carafoli")** Click to join the Hybrid Meeting		
Invited Speakers **15:10 – 16:10**		**Chair: Catalin NAE**, President & CEO, INCAS		
15:10	**15:40**	**"Advanced air mobility: a dream nearing fulfillment"** **James A. SHERMAN** | Aviation Forum Executive – American Institute of Aeronautics and Astronautics (AIAA), USA		
15:40	**16:10**	**"Artificial Neural Networks use in Unmanned Aerial Systems Modelin"** **Ruxandra Mihaela BOTEZ** | ETS, University of Quebec, Montreal, Canada		
16:10	**16:20**	**Break**		
ROOMs Session **16:20 – 18:20**		**ROOM 1 (Amf. "Elie Carafoli")** Click to join the Hybrid Meeting	**ROOM 2 (Materials and Tribology)** Click to join the Hybrid Meeting ROOM 2	**ROOM 3 (Corp B. et. 2)** Click to join the Hybrid Meeting ROOM 3
Session Title		**Aerodynamics**	**Materials and Structures**	**Systems, Subsystems and Control in Aeronautics**
Session Chair(s)		**Valentin Adrian Jean BUTOESCU** *(INCAS)* **Daniel-Eugeniu CRUNTEANU** *(UPB)*	**Adriana STEFAN** *(INCAS)* **Viorel ANGHEL** *(UPB)*	**Ioan URSU** *(INCAS)* **Sorin Stefan RADNEF***(INCAS)*
16:20	**16:40**	S1.5 **Study of an autonomous hybrid solar - wind renewable energy system using HOMER** ***Alexandru DUMITRACHE*,*** *Sergiu-Alexandru POPESCU,* *Radu BOGATEANU*	S4.7 **Thermo-mechanical properties of fused filament fabricated PLA at elevated temperatures** *Mihail BOTAN,* ***George PELIN****,* *Adriana STEFAN,* *Cristina- Elisabeta PELIN,* *George- Cătălin CRISTEA*	S5.1 **Study on commutation of power supplies used in a solar UAV** ***Andrei BUZDUGAN****,* *Nicolae JULA*
16:40	**17:00**	S1.6 **Airfoil lift prediction using a neural network** ***Adrian CHELARU****	S4.8 **Spring-in simulation of a large scale demonstrator CFRP wing box** ***Mircea BOCIOAGA*,*** ***Cesar BANU*,*** *Laurentiu-Nicolae FIRTAT*	S5.2 **Visual based GNC system from prototype to flight software** ***Florin-Adrian STANCU*,*** *Víctor Manuel MORENO VILLA (Es),* *Carlos DOMÍNGUEZ SÁNCHEZ (Es),,* *Andrei Valentin PLĂMĂDEALĂ,* *Daniel OVEJERO PROVENCIO (Es)*
17:00	**17:20**	S1.7 **Roll damping coefficient determination and correction for Basic Finner Model** ***Ionuț BUNESCU*,*** *Mihai-Vlăduț HOTHAZIE,* *Mihai-Victor PRICOP,* *Mihăiță Gilbert STOICAN*	S4.9 **Mathematical description of the functioning of the pulsatory liposome** ***Dumitru POPESCU*,*** *Dumitru Petru IGA,* *Alin Gabriel POPESCU,* *Valentin I. R. NICULESCU*	S5.3 **Calculation of steering system parameters of a military training aircraft** ***Bogdan Adrian NICOLIN****,* *Ilie NICOLIN*
17:20	**17:40**	S1.8 **Aerodynamic study of a small rocket engine** ***Mihai Leonida NICULESCU*,*** *Adrian TOADER*		S5.4 **Actuator fault reconstruction using FDI system based on sliding mode observers** ***Florin-Adrian STANCU*,*** *Adrian-Mihail STOICA*
Session Title		**Management in Aerospace Activities**		
Session Chair(s)		***Sorin Stefan RADNEF*** *(INCAS)*		
17:40	**18:00**	S8.1 **Contractual Requirements Review and Management** ***Manuela RUSU*,*** *Ilinca SOARE,* *Valentin SOARE,*		

		Sergiu TONOIU, *Ovidiu BLAJINA*				
18:00	**18:20**	S8.2 **Considerations regarding the risk of using counterfeit products in the aerospace industry** ***Ilinca SOARE*,*** *Manuela RUSU,* *Valentin SOARE,* *Sergiu TONOIU,* *Ovidiu BLAJINA*				
End of the 1st Day of the 10th "AEROSPATIAL", Hybrid Conference						

Day 2 | Friday, 14 October 2022

Time (CET)		Plenary ROOM 1 (Amphitheater "Elie Carafoli") Click to join the Hybrid Meeting
10.00	10:10	**Welcome and introduction** by the Conference Chairman Dr. Eng. **Catalin NAE**, President & CEO, INCAS – National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania Dr. Fiz. **Adriana STEFAN**, President of the Scientific Council of the INCAS – National Institute for Aerospace Research "Elie Carafoli", Romania
10:10	11:00	**The "Nicolae TIPEI" – Prize Award Ceremony** **The "Gheorghe VASILCA" – Prize Award Ceremony** - ***Tribute presentation of awards*** *by Dr. Eng.* ***Victor MANOLIU*** *(INCAS)* - ***Presentation of the awarded works*** - ***The winners' speech***
Invited Speaker **11:00 – 11.30**		**Chair: Catalin NAE** *(INCAS)*
11:00	11.30	**"Current and future materials research in aerospace"** **Svjetlana STEKOVIC** | Associated Professor/ Docent at the Division Engineering Materials, the Department of Management and Engineering, Linköping University, Linköping, Sweden
11:30	11:50	**Coffee Break**

ROOMs Session 11:50 – 14:20		ROOM 1 (Amf. "Elie Carafoli") Click to join the Hybrid Meeting	ROOM 2 (Materials and Tribology) Click to join the Hybrid Meeting ROOM 2	ROOM 3 (Corp B. et. 2) Click to join the Hybrid Meeting ROOM 3
Session Title		Aerodynamics	Round Table – Current and future challenges in advanced materials and processes	WORKSHOP "Propulsion systems with detonation"
Session Chair(s)		**Valentin Adrian Jean BUTOESCU** *(INCAS)* **Alexandru-Iulian ONEL** *(INCAS)*	**Mihail BOTAN** *(INCAS)* **Konrad KOZACZUK** *(ILOT)*	**Ionut PORUMBEL** *(COMOTI)* **Daniel-Eugeniu CRUNȚEANU** *(UPB)*
11:50	12:10	S1.9 **Trajectory simulation of EGLIN test case using overset mesh and adaptive mesh** ***Georgiana ICHIM**** *Ioan – Laurențiu PĂDUREANU*	***INCAS – National Institute for Aerospace Research "Elie Carafoli" - Advanced materials and Tribology*** ***Mihail BOTAN****, **Adriana STEFAN****,* *Cristina- Elisabeta PELIN, George PELIN,* *George- Cătălin CRISTEA* **Łukasiewicz Research Network – Institute of Aviation- Composite Technologies Center** ***Konrad KOZACZUK*** *(PI),* *Małgorzata ZALEWSKA (PI),* *Piotr KOPERNIAK (PI),* *Bartłomiej WAŚNIEWSKI (PI)*	W6.1.1 **Review of pulsed detonation engine aerodynamic systems** *Andrei Vlad COJOCEA,* *Mihnea GALL,* ***Daniel Cristian ASOLTANEI****,* *Tudor CUCIUC*
12:10	12:30	S1.10 **Numerical simulations of a general aviation aicraft in the high-lift configuration** ***Ioan – Laurențiu PĂDUREANU,*** *Ștefan BOGOS,* *Dorin BÂRSAN,* *Bogdan RUSU*		W6.1.2 **Detonation wave characterization in pulsed detonation engine** ***Andrei Vlad COJOCEA****,* *Mihnea GALL,* *Daniel-Cristian ASOLTANEI,* *Tudor CUCIUC,* *Cornel Mihai TĂRĂBÎC*
12:30	12:50	S1.11 **CFD Numerical Predictions for Aerodynamic Roll Damping Coefficients on Basic Finner Model** ***Mihai-Vladut HOTHAZIE****,* *Ionut BUNESCU,* *Mihai-Victor PRICOP,* *Dumitru PEPELEA*	**Q & A**	W6.1.3 **A review of detonation based combustion architectures for modern propulsion systems** ***Andrei Vlad COJOCEA****,* *Daniel Eugeniu CRUNȚEANU*
12:50	13:00	Session change	Restricted Session	W6.1.4 **Analyzes regarding parameters of aviation fuels use on jet engines** ***Vasile PRISACARIU****,* *Irina ANDREI,* *Eduard MIHAI,* *Alexandru TUDOSIE*
Session Title		WORKSHOP "Automatic LAnding on MObile PLATform (ALAMOPLAT)"		
Session Chair(s)		**Achim IONITA** *(INCAS)*		
13:00	13:20	S5.1.1 **ALAMOPLAT Robotic System – a facility for RvD Simulation, Tests and Verification. Results and future development** ***Achim IONIȚĂ****,* ***Mihai TUDOSE**** *Nicolae APOSTOLESCU,* *Mihai TUDOSE,*		W6.1.5 **Parametric analyzes of jet engines combustion chambers** ***Vasile PRISACARIU****,* *Irina ANDREI,* *Ionică CÎRCIU,* *Alexandru TUDOSIE*
13:20	13:40	S5.1.2 **Use of robotic system for SIL/HIL simulation of an aerospace vehicle approach on a mobile platform** ***Florin COSTACHE****,* ***Sandra NICHIFOR****,*		**Q & A**

		Daniel VIȘAN, *Achim IONIȚĂ*				
13:40	**14:00**	S5.1.3 **Autonomous landing of a mobile air vehicle on a moving target** ***Sandra NICHIFOR****,* ***Florin COSTACHE****,* *Nicolae APOSTOLESCU,* *Mihai TUDOSE,* *Daniel VIȘAN,* *Achim IONIȚĂ*				
14:00	**14:20**	S5.1.4 **Software solution for Operational Monitoring and Control (OMC) of Robotic System on INCAS – Maneciu platform** ***Nicolae APOSTOLESCU****,* ***Achim IONIȚĂ****				
End of the 2rd Day of the 10th "AEROSPATIAL", Hybrid Conference						

Conference Topics

Section 1. Aerodynamics - S1
Section 2. Flight Mechanics and Systems Integration - S2
Section 3. Astronautics and Astrophysics - S3
Section 4. Materials and Structures - S4
Section 5. Systems, Subsystems and Control in Aeronautics - S5
Section 6. Experimental Investigations in Aerospace Sciences - S6
Section 7. ATS and full Automation ATM - S7
Section 8. Management in Aerospace Activities - S8

Events associated with of the conference

- The "Nicolae TIPEI" Prize Award Ceremony - 14 October 2022
- The "Gheorghe VASILCA" Prize Award Ceremony - 14 October 2022
- Workshop "Detonation based propulsion systems" - 14 October 2022
- Workshop "Automatic LAnding on MObile PLATform (ALAMOPLAT)" - 14 October 2022
- Round Table - Current and future challenges in advanced materials and processes (INCAS – ILOT) - 14 October 2022
- Exhibitions: INAS, CENIT, HEXAGON, INCAS – 13 -14 October 2022

Partner in support of the Awards gala event

- Chateau Vartely

Invited Speakers

(in alphabetical order of the first author)

Artificial Neural Networks use in Unmanned Aerial Systems Modeling

Ruxandra Mihaela BOTEZ

Abstract: It is known that manufacturers need to manufacture unmanned aerial vehicles (UAVs) with best performances for various operations, such as surveillance, rescue or delivery. An optimum UAV would need to convert minimum electrical energy to thrust while ensuring excellent aerodynamic flight performances; this type of design requires knowledge from mechanical, electrical and chemical engineering. In order to select the best elements for designing of an optimal update of an UAV, it is important to design highly accurate models that would predict its efficiency for different flight situations. An UAV efficient design would require its efficient engine model. In this abstract, a Brushless Direct Current (BLDC) model design based on artificial intelligent methodologies is presented.
The BLDC model was designed, tested and validated using public data, therefore it is very easy for any manufacturer to verify the artificial neural network methodology here explained. This methodology was programmed using Matlab software and it used a very large range of public data, that were collected from manufacturers websites, or from their real test bench measurements. The relative errors were very small: 0.20% for the rotational speed and 0.45% for the torque, therefore the BLDC model was verified and validated with experimental data.

Key Words: Artificial Neural Network, UAV, MATLAB, Engine

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Towards a full composite large passenger aircraft: some critical environmental aspects

Antonio CONCILIO*,[1], Salvatore AMEDURI[1]

Abstract: Morphing in aerospace targets the improvement of aircraft performance through changes of critical geometrical features to adapt its shape in evolving operation conditions. Standing its potentiality, the development path of such a technology is complex and shall pass through articulated gates to prove its readiness level, because of the concurrence of expertise and novel design approaches. Characterization and demonstration of the concepts in representative environments, as wind tunnel test facilities, is one of the most relevant steps needed for its engineering maturation. In that case, facility size limitations do usually impose the use of scaled models. Since morphing systems architectures are strictly dependant on the available room, and their performance is tightly correlated with the structural stiffness, changes in dimensions may affect their overall behaviour, significantly. The result is that the adaptive design may change a lot, till arriving to completely different layouts. Exploitability issues of a certain architecture to other classes of vehicles are related to that aspect. Relevant and validated numerical models are used to conduct the above-mentioned preliminary studies to track different evolution laws of some characteristic parameters of the adaptive structural system vs selected scale factors. The achieved results confirm the complexity of attaining an effective reproduction of the parent architectures scaled models are addressed. In spite of the established specificity of the analysis, it is believed that the outcomes may have a general validity in establishing some general guidelines that could be exported towards other configurations.

Key Words: Scaling effects, structural morphing systems, shape memory alloys, adaptive structures, integrated actuators, geometrical layout, mechanical configuration, rotorcraft blade

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Hybrid manufacturing of thermoplastic composite structure

Konrad KOZACZUK, Bartłomiej WAŚNIEWSKI, Wojciech KRAUZE

Abstract: The paper presents the work of the team of the Composite Technologies Center in field of manufacturing of thermoplastic composite structures. The advantages and limitations of press forming process and Automated Fiber Placement in situ consolidation are presented. The main limitations of press forming process are significant material waste and the inability for layup optimization across the part. The advantages of this technology are fast manufacturing process as well as good quality of the part and high properties of the material. In the case of AFP in situ consolidation, the point where the restriction occurs is low production speed and reduced material properties. The advantages of this technology are the low material waste and the possibility of optimizing parts layup. Both technologies, due to the thermoplastic materials application, give opportunity for easy parts recycling, which is important from sustainability point of view. During the R&D work, the team developed the hybrid technology by combining press forming process and AFP consolidation. The use of AFP technology to prepare the prefabricated part made it possible to optimize the layup arrangement and reduce material waste. The optimized parameters of the AFP robot allowed for the speed up of production. Final consolidation with a heating press ensures excellent part quality Forming prefabricated parts with AFP process can take place on simplified geometry, which allows the final production of more complicated parts, with a geometry not available for each of the above-mentioned technologies separately. In the case of AFP technology, the limiting factor for part complexity is kinematics and size of AFP head. Regarding press consolidation, where parts are made from pre-consolidated flat panels, parts geometry is limited to avoid formation of wrinkles on challenging geometry. The usage of the simplified prefabricated part solved both problems.

Key Words: composites structures, thermoplastic composites, automated fiber placement, thermoforming, in situ consolidation

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A real application in gate assignment problems combining optimization, simulation, and delay prediction

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Abstract: This study couples a commercial airport simulator with an external optimization algorithm to improve the provided a near-to-optimal solution, and to increase the gate assignment robustness, delays and early arrivals affecting departure and arrival times predicted using machine learning techniques in the gate assignment problem of the Zurich International Airport. The flight delays are predicted with expected arrival/depurates data and historical weather information such as precipitation, wind, etc. Predictions were used to update the planned arrival/departure time input initially provided by the airlines or/and the airport. The gate assignation model used was a commercial simulator (CAST) as a black box. CAST and the external developed genetic algorithm communicate with a two ways protocol to improve the solution. CAST provides a pre-optimized solution which in turn used this initial solution as input for the genetic algorithm. The combination of the three techniques generates an architecture that: allows the implementation of more realistic constraints than the typical set of equations used in standard analytical models, the use of a data-based predictor to the arrival/departure times before optimization to make the assignation solution more robust and; to develop an external optimizer that interacts with the detailed simulation model improving the initial solution. Results have showed that the predictor algorithm made the provided solution more robust as less flights were disrupted when compared against the planned schedules. The optimization algorithm was able to reduce the gate allocation costs for a busy airport such as the Zurich International Airport compared against the solution provided by CAST, and it was able to even allocate more flights for mid-size airports compared against the results provided by CAST.

Key Words: Optimization, Gate Assignment Problem, Machine Learning, Delays, Predictor, Genetic Algorithms. Simulator

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Advanced air mobility: a dream nearing fulfillment

James SHERMAN

Abstract: For over 50 years, personal flying vehicles has been a dream kept alive through cartoons and sci-fi films. In the last 10 years, inventive entrepreneurs have been working hard to fulfil the dream through unique, sustainable designs. Over the past 6 years, over 700 vehicle designs have been proposed, and dozens are undergoing a flight testing program with a goal of gain regulatory approval. This presentation will highlight the current state of the development of this burgeoning industry, including the development of tools, materials and infrastructure required for implementation of low-altitude flight. This industry is anticipating having passenger-capable and cargo aircraft certified in 2024 and operations starting in 2025 in select markets.

Key Words: Electric Vertical Takeoff and Landing (eVTOL), Advanced Air Mobility (AAM), certification, aircraft design, electric propulsion, electric aircraft, Urban Air Mobility (UAM)

advanced materials for both airframe and aeroengine applications.

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Current and future materials research in aerospace

Svjetlana STEKOVIC

Abstract: Recent global developments have uncovered long predicted crises, such as the climate crisis and extreme weather events, but also unexpected crises, such as the Covid-19 pandemic or the Ukraine conflict following by energy crisis and inflation. Regardless of if we could foresee them or not, these crises have put focus on energy and materials supply, fuel costs, manufacturing agility and sustainability requiring cost effective, competitive and green solutions related to materials, production technologies, software tools, etc. Aerospace is, therefore, entering an exciting new era where technological revolution needs to take place together with technological evolution in different areas to achieve the sustainability and greenhouse gas emissions targets set by the European Union, and the United Nations Sustainable Development Goals. Therefore, I am going to talk about current and future materials research in aerospace covering structural advanced materials for both airframe and aeroengine applications.

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Section 1 – Aerodynamics

(in alphabetical order of the first author)

Design and analysis of a morphing winglet based on a biomimetic mechanism with flexible composite skin: Application on the UAS-S45

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Abstract: This study proposes a morphing Droop Nose Leading Edge winglet design methodology using a flexible composite skin applied to the UAS-S45. The deformation mechanism of the morphing winglet was bioinspired by a honeybee abdomen structure. The study has shown that this biomimetics methodology has improved the wing's aerodynamic performance over the reference unmorphed geometry performance. The leading-edge deflection mechanism mimics a honeybee's abdomen's bending and flexing motions. It uses a flexible skin, while the deformation is controlled via three linear servos that would allow for the flexible mechanism's stretching and retraction. The three different servos are used for control, and their associated kinematics is explained in the study. The flexible composite skin laminates on the winglet were subjected to a stress analysis under various loads in order to provide pre-analysis results using Classical Lamination Theory (CLT). The stacking sequence of composite plies used during the computation was [90/45/-45/0]. The study also included the comparison of two composites: Carbon Epoxy and Glass Fiber Reinforced Plastic (GFRP) for the composite modelling. The geometry was modeled using Ansys Composite PrepPost (ACP), while Ansys Mechanical was used to compute the stress analysis confirming the results for loading cases. A proof-of-concept demonstrator mechanism was manufactured of PolyEthylene Terephthalate Glycol (PETG), and the deformation for the target winglet shape was analyzed from the demonstrator. The structural analysis results concluded that an appropriate composite layup orientation was obtained for the winglet while minimizing the structural weight of the UAS-S45 winglet.

Key Words: Morphing Winglet, Droop Nose Leading Edge, Composite material, Honeybee inspired morphing mechanism, Finite Element Analysis, PLA

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Roll damping coefficient determination and correction for Basic Finner Model

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Abstract: The development and calibration of a roll damping identification rig for high-speed blow-down facilities is presented. Although the roll damping coefficient determination method is implemented in wind tunnels, most of them do not have this testing capability, though the aerodynamic damping derivatives is being required for many aerospace vehicles. The methods used for roll damping determination, the components of roll damping rig, the experimental data obtained and the method used for data correction are introduced with various details. The experimental dataset obtained using the Roll Damping Rig (RDR) represents the calibration data for the Basic Finner Model, that is well presented in the literature. Finally, the tare and data correction procedures are presented for the two methods used for roll damping measurement: forced and free.

Key Words: roll damping coefficient, experimental dynamic measurement, wind tunnel, Basic Finner Model, damping rig calibration

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Airfoil lift prediction using a neural network

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Abstract: In the past few years, Machine Learning (ML) and Artificial Intelligence (AI) have become of great interest in the field of science. This is also true for the field of aerospace and aeronautical.
The aerospace industry in always interested in speeding up the process of development. Because of this, artificial intelligence can be applied to several different sectors of the aerospace industry, such as air traffic management, enhance operational efficiency, product design, customer service, pilot training and research.
In this paper we are going to investigate how artificial intelligence can be applied in the field of CFD.

Key Words: CFD, Machine Learning, Neural Network, Artificial Intelligence

Key Words: overset mesh, adaptive mesh, store-separation, 6DOF, EGLIN test case, CFD

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Study of an autonomous hybrid solar - wind renewable energy system using HOMER

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Abstract: This work aims to analyse and derive power supply solutions for domestic users in regions with solar potential and low/moderate wind speeds in rural and urban areas. From the analysis of the wind speed distribution in Romania it is found that the average wind speed is between 4 and 7.5 m/s, and these regions also coincide with areas of high solar radiation. The solution proposed to be analysed in this work is a hybrid system composed of a high performance vertical axis wind turbine (with start-up at low wind speeds, in the order of 1.5 - 2 m/s) and photovoltaic panels.
The use of vertical axis wind turbines (VAWT) offers a number of advantages over traditional horizontal axis wind turbines (HAWT).
The electrical system will incorporate large capacity batteries. The electrical system will be served by an electrical management system, allowing optimal use of the electricity generated by the turbines and the photovoltaic system.
The photovoltaic (PV) power system consists of several components, including photovoltaic modules, means for regulating and/or modifying the electrical output, an energy storage unit in the case of stand-alone systems, electrical connections and mounting. The hybrid system is optimised using HOMER.

Key Words: VAWT, PV, Renewable Energy, Hybrid System, HOMER software

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CFD Numerical Predictions for Aerodynamic Roll Damping Coefficients on Basic Finner Model

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Abstract: Accurate prediction of aerodynamic damping coefficients is essential in designing aerodynamic configurations and requires wind tunnel testing capabilities. Although semi-empirical methods were used to predict the dynamic response and supplement wind tunnel testing, the feasibility and accuracy for highly complex configurations is in question. Nowadays, advancements in computational power coupled with optimized numerical routines and methodologies have enabled the development of numerical prediction methods based on Computational Fluid Dynamics. To optimize the computational requirements for an unsteady flow simulation, a method to predict the roll damping coefficient is presented based on a multi reference frame approach where steady-state numerical solutions are obtained by solving RANS equations. The widely used research model Basic Finner is used to validate the numerical results with experimental

data from various wind-tunnels testing facilities in order to use RANS as interpolation data for wind tunnel campaigns with small experimental points, due to various limitations.

Key Words: roll damping coefficients, CFD, Basic Finner Model, numerical methods, multi reference frame, steady-state simulation

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Trajectory simulation of EGLIN test case using overset mesh and adaptive mesh

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Abstract: Overset mesh and adaptive mesh techniques are applied for a transient store separation problem. The resulting trajectories are validated against the available experimental data from EGLIN test case. With a proper workflow, utilizing CFD for store separation from air vehicles is less expensive and more reliable than wind tunnel testing. In this regard, a good quality mesh with tetrahedra elements is generated in Ansys Meshing to predict the store motion in transonic conditions. The adaptive mesh generation process has less control of its quality during simulation whereas for the overset mesh the quality is preserved as it uses individual meshes for the background and store. The center of gravity's trajectory is predicted by coupling a density-based solver with a six degree of freedom (6DOF) solver in ANSYS Fluent. Using the overset mesh shows good agreement with the experimental data, thus determining a stable workflow for future store separation simulations.

Key Words: overset mesh, adaptive mesh, store-separation, 6DOF, EGLIN test case, CFD

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Morphing Trailing Edge with Seamless Transition Flaps: A High-Fidelity Optimization Study

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Abstract: In this study, a morphing trailing edge with seamless transition flaps is optimized in the cruise flight condition with the aim to maximize the flight range and endurance. Two high-fidelity aerodynamic optimization analyses are performed, using OpenFOAM and Python interface with the DAFoam optimization framework [1]. Gradient-based optimization algorithm using a discrete adjoint method is applied with the objectives of maximizing flight range and endurance for a propeller engine unmanned aerial system UAS-S45. The optimized seamless morphing flaps are then compared to their corresponding hinged flap configurations with gaps in transition sections in terms of aerodynamic performance. For the first objective function (range maximization), the results indicated up to 33% gain for the morphing seamless flap compared to the unmorphed flap configuration and up to 14% gain compared to the hinged flap configuration with the same deflection angle as the seamless morphing flap at zero angle of attack. For the second objective function (endurance maximization), up to 61.2% improvement was obtained for the morphing seamless flap compared to the unmorphed flap at zero angle of attack. However, as the angle of attack increased, the optimum angle of deflection decreased to lower deflection angles while the influence of morphing seamless flap reduced. The critical angle of attack, for which the morphing seamless flaps and unmorphed wing have the same aerodynamic performance has the values of 2.5° and 7° for maximum range and endurance (first and second objective functions), respectively. For higher angles of attack (higher than 2.5° and 7°), the unmorphed flap configuration performed better than that of the deflected flap in terms of flight range and endurance.

Key Words: morphing wing, trailing edge seamless flap, aerodynamic optimization, flight range, endurance, gradient-based optimization

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Aerodynamic study of a small rocket engine

Mihai Leonida NICULESCU*[,1], Adrian TOADER[1]

Abstract: This paper presents an aerodynamic study of a small rocket engine designed by INCAS. The authors have paid a special attention to ethanol's burning. The values obtained for specific heat ratio of burning gases are significantly smaller than those recomandated in literature due to the ethanol whose specific heat ratio is 1.13 at 25°C and rich fuel mixture. The axisymmetric gas dynamic computations have shown that the real thrust is significantly lower than that predicted by the classic thermodynamic relations.

Key Words: rocket engine, ethanol burning, CFD, specific heat ratio, thrust

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Numerical simulations of a general aviation aicraft in the high-lift configuration

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Abstract: The results of numerical simulations on a general aviation aircraft in the landing configuration are shown. The high-lift airfoil features a 28% chord slotted flap, but the 3D is modeled without the flap supports. For a higher certainty level, three grids with increasing level of refinement are used to perform a convergence study. ANSYS Fluent is used to perform the simulations at different angles of attack up to stall. The initial conditions to the simulation can have a significant influence, at high angles of attack, on the excessive flow separation and the premature stall onset. This numerical hysteresis was avoided by using as initial conditions the results from a lower angle of attack. At the moment there are no experimental data available and therefore the level of accuracy, especially at high angles of attack, remains to be determined when the planned wind tunnel results will be available.

Key Words: high-lift devices, trailing edge flap, RANS, CFD.

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Active Flux Scheme for Time-Dependent, Viscous, Compressible Flows

Oliviu ȘUGAR-GABOR*

Abstract: The Active Flux scheme is a Finite Volume scheme with additional degrees of freedom on the cell boundaries. These additional nodes allow for third-order accuracy to be achieved, though extensions to higher orders are also possible. Unlike Godunov-type Finite Volume schemes, Active Flux makes use of a continuous reconstruction across the cell faces and does not require a Riemann solver. The variable values at the additional degrees of freedom on the cell faces are evolved independently from the cell-average values, using (non-conservative) compact-stencil schemes most suited to the mathematical and physical properties of the equations being solved. Overall conservation is enforced via the cell-average values which are updated in a step following the evolution of the additional degrees of freedom. The fundamentals of the Active Flux scheme are presented using a simple application on the Burgers equation. An evolution operator for both linear and nonlinear hyperbolic conservation systems is presented and then extended to include source terms. Example applications are made on the Euler equations and a hyperbolic formulation of the diffusion equation. Lastly, for the compressible Navier-Stokes equations, a hyperbolic formulation is presented together with an operator splitting approach. These allow for the Active Flux evolution operators to be applied to the numerical computation of viscous, compressible flows.

Key Words: active flux scheme, finite-volume method, hyperbolic conservation laws, source terms, operator splitting, compressible Navier-Stokes

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Non-Intrusive Reduced-Order Model for Unsteady Fluid Flow and Fluid-Structure Interaction Problems

Oliviu ȘUGAR-GABOR*,[1], Daniel FAIRCHILD[1]

Abstract: A non-intrusive reduced-order model applicable to time-dependent parametric systems is developed. The model is based on extracting a reduced-order basis from high-order snapshots via proper orthogonal decomposition. Multi-layered feedforward artificial neural networks are used to capture the unsteady behaviour of the reduced-order coefficients. Nonlinear regression networks using Radial Basis Functions are used to approximate the parameter space behaviour of the reduced-order coefficients, ensuring the method is applicable to problems having an arbitrary number of parameter samples. An adaptive sampling approach based on determining the relative influence of each parameter sample on the overall approximation is implemented. This increases the quality of the neural network prediction while minimising the required number of parameter samples and the number of high-order snapshots. The resulting model is fully non-intrusive, it is independent of the high-order computational method and can be used together with black-box solvers. First, numerical studies for two canonical fluid flow test cases, unsteady incompressible laminar flow around a circular cylinder and transonic inviscid flow around a pitching NACA 0012 aerofoil. Next, two fluid-structure interaction test cases are considered, sinusoidal pressure waves interacting with a metallic rod, and large-displacement oscillation of an elastic beam in incompressible laminar flow. Results confirm the accuracy of the non-intrusive approach for the various tests considered.

Key Words: non-intrusive reduced-order model, proper orthogonal decomposition, artificial neural networks, incompressible and compressible flow model order reduction, fluid-structure interaction

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Section 3 – Astronautics and Astrophysics

(in alphabetical order of the first author)

Relative Mechamical Movement of Bodies in Outer Space - the relative inertia

Sorin Stefan RADNEF

Abstract: Even that the classical mechanics states that it is not possible to find an inertial frame of reference, there are used relative measurements to determine the mechanical behaviour of celestial bodies having very small dimensions compared with the distances between them. The present work aims to demonstrate that the two fundamental theorems of mechanics, the momentum theorem and the moment of momentum theorem, remain valid if we use the relative distances and velocities between these celestial bodies.The starting point for the development of such a result is that the basic assumptions of newtonian mechanics are supposed to be valid and are used considering that an inertial reference frame may exist, even if we are unable to foind it. Relationships are established between the relative accelerations and the global forces acting on each body in a two-body assembly, relationships which are quite similar to those stated in an inertial frame of reference.

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Section 4 – Materials and Structures

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FEM Applications of Catenary Type Structures

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Abstract: The paper deals with Finite Element Modeling of catenary type structures starting from practical problems related to a single cable segment in the case of an electric transmission line. FE models allow the analysis of the resulting deformed position and stress state for a given configuration obtained by using the geometric and physical data of a cable. Beam type linear/nonlinear finite element models which can take into account also the temperature variation and extra loading on the cable were developed. Another application of this type of models is for the case of form finding of aerial refueling cable subjected to dynamic pressure. The results were obtained by the commercial finite element software ANSYS.

Key Words: Catenary, Single Cable Segment, Transmission Line, Aerial Refueling Cable, ANSYS

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Spring-in simulation of a large scale demonstrator CFRP wing box

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Abstract: Based on a new manufacturing technology, one of the goals of ELADINE project was to develop a Finite Element Numerical Model to replicate the manufacturing process of a 7 m composite wing demonstrator. The main objective of the FE model was to predict in a reasonable margin of error the spring-in phenomena that occurs in the skin-spars assembly of the wing. The FEM model respect the geometrical constraints of the CAD model and replicate as precise as possible the geometrical characteristics of the parts that may influence the final geometry of the assembly.
The Numerical Model developed in the ELADINE Project is a transient multiphysics model. It includes a mathematical model to simulate the curing and cure shrinkage process, thermal analysis, to simulate temperature field at different moments of the manufacturing, thermal expansion effects, and structural analysis to simulate the part distortion due to curing in the condition of a thermal field variation.
To simulate the distortion effects, the Numerical Model also considers variable material data as a function of cure degree.

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Microstructure, microhardness and thermal shock behavior of laser cladding MCrAlY based alloy on Nimonic 90 substrate

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Abstract: This paper presents recent research of the authors, regarding laser cladding of MCrAlY (where M is used for Ni, Co or both) based alloy on Nimonic 90 substrate. The coatings based on McrAlY are widely used as a bond coat in thermal protection systems for extreme thermal environments components such as gas turbine engines and arc heaters. Microstructure, microhardness and thermal shock behavior of MCrAlY coating by diode laser cladding process was investigated and analyzed. Thermal shock behavior (at 900℃ and 1000℃) is a decisive parameter for extreme environmental coatings, where a strong interlayer bonding between coatings and substrates is required.

Key Words: Laser cladding, MCrAlY, Thermal shock, coatings, microhardness

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A (Historical) Review of Deployable Reflector Antennas for Space Applications

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Abstract: From the 20th century the development of deployable antennas and deployable antenna systems had started to be the focus of many researchers and researcher institutes, as well as commercial space companies and academia. The main advantage of the deployable antennas is their property of occupying smaller housing within a spacecraft than a solid antenna. In the case of the deployable reflector antennas, the theory and practice confirm that the greater the aperture, the greater the data obtained. In order to develop and build an antenna of such type, the following main areas need to be covered and approached concomitantly: antenna reflective surface which acts as antenna main reflector, antenna sub-reflector, antenna feed system and mechanical support structure. All sub-subsystems shall work together to obtain the optimal RF performance of the antenna system. This study comprises a historical overview, highlighting the main deployable reflector antenna properties and the study motivation of each type. A classification is made as well, together with a summary of advantages and disadvantages of the developments. The main important scientific achievements are extracted and at the end of the study a critical analysis is performed, having as main conclusion the future direction of the developments.

Key Words: space, deployable antenna, deployable reflector antenna, RF performance

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Aspects regarding the load transmissibility on a squeeze film damper supported rotor

Laurentiu MORARU

Abstract: Many types of bearings and dampers are available for the rotors of ground operating rotating machines; however, the tuning of the dynamic coefficients of shaft supports within aerospace propulsion systems,(shafts that must be supported on rolling elements bearings) is significantly more difficult, due to space and weight restrictions and it usually relies on squeeze film dampers (SFD). SFDs are essentially non-spinning hydrodynamic bearings (only precession and nutation motions are permitted within the oil film) installed around the ball bearings housings. This paper discusses some aspects regarding the load transmitted to the structure in the case of a rotor supported on SFD

Key Words: Squeeze film dampers (SFD), hydrodynamic bearings, rotor dynamics

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Lightweight reinforced thermoplastic materials for vacuum thermoformed encapsulation applications in unmanned aerial vehicles (UAVs)

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Abstract: The paper focuses on presenting the concept and main experimental objectives of a newly funded project entitled "Lightweight reinforced thermoplastic materials for vacuum thermoformed encapsulation applications in unmanned aerial vehicles". The project is designed to support the constantly evolving field of unmanned aerial vehicles (UAV) and their continuously increasing requirements, strongly connected to aviation, military, and national security areas as well as socio-economical and sanitary areas. The topic aims to develop a lightweight, durable and strong solution based on thermoformable materials, designed to act as protective covers for different electronic parts of UAVs, achieved through simple, low-cost technology. The scope of the project comes from a necessity identified by INCAS in customized UAVs, that requires the protection of the sensitive and expensive electronic elements of the UAV body against environmental phenomena (rain, snow, wind, dust, extreme temperatures, etc) and unexpected incidents (obstacles

crashes, bird collisions, etc), all while keeping the cover added weight gain to a minimum. The preliminary solutions consisted of easily processable and lightweight materials, but with mechanical performance below the standards of the target application. The project proposes the development of protective covers based on thermoplastic polymers (mainly, different types of grafted polypropylene, but considering also polyethylene terephthalate) reinforced with uniformly dispersed aramid nanofibers, previously subjected to surface modification treatments for strengthening chemical bonding and enhancing mechanical interlocking between the two phases. Using modified aramidic nanofibers is expected to achieve high-strength composites while keeping the weight gain to a minimum. The technological process will consist of nanofilled composite sheets development followed by vacuum thermoforming of the sheets into complex shape covers according to the encapsulation geometry requirements. Extensive characterization and testing of the nanofilled thermoplastic will be performed in order to evaluate the material's performance and anticipate their behaviour during vacuum thermoforming, that will ease the parameters setting during this stage. The topic supports the achievement of sustainable development goals addressing environmental considerations, energy-efficient technologies, and long-term stability.

Key Words: thermoplastic polymers, modified aramid fibers, nanocomposite UAV covers

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Thermo-mechanical properties of fused filament fabricated PLA at elevated temperatures

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Abstract: This study aims to present the authors' recent research regarding the investigations of mechanical and thermo-mechanical properties of commercial polylactic acid (PLA) polymer. The polymer samples were manufactured by the 3D printing process of fused filament fabrication (FFF) and the tests were performed according to ASTM International standards for polymers D638, D695 and D790. All test samples were prepared using the same printing process parameters. The static mechanical tests consisted of tensile and flexural loadings at various temperature ranges from room temperature to elevated temperature (25°C, 40°C and 50°C respectively). For ensuring that the additively manufactured products can resist severities of real-life applications, thermal stability under mechanical load tests HDT (heat deflection temperature) were carried out. The influences of temperature on the mechanical and thermomechanical properties were determined and presented, and a synthesis of the characteristics was made in accordance with the applications of products based on the studied material.

Key Words: polylactic acid, mechanical and thermo-mechanical properties, 3D printing, fused filament fabrication

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Mathematical description of the functioning of the pulsatory liposome

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Abstract: We adopt a model in which the time evolution of a solution-charged liposome with selective permeability is seen as a sequence of two-stage cycles. In the first stage the lipid vesicle with a certain input concentration of the active substance is swelling up in an osmotic process until it reaches a size that one pore is formed on its surface. The second stage follows, where the vesicle content is partially eliminated through the pore to induce a decrease of the vesicle volume up to its original size. A new cycle is then

initiated with the remaining concentration of the active substance for input, and so on. The swelling of the liposome is described by a differential equation. All the processes which contribute to the vesicle relaxing and its come back to the initial size are described by three differential equations.The activity of a pulsatory liposome can be characterized by the following parameters: a) number of cycles, the length time of each cycle and liposome activity life; b) the length time of the swelling stage and of the relaxation stage for each cycle; c) the quantitie of solute leaked out through the pore in each cycle.

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Experimental studies on grease performance during operating time

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Abstract: The purpose of the paper is to investigate the rheological and tribological properties of a complex lithium - calcium grease, using a con and plate viscometer and a pin-on-disk. The experiment was performed on a fresh grease and on the same grease, used in a worm gear. For both samples of grease, the effect of tackiness and adhesion phenomenon was studied. Finally, it has been observed a strong dependence between the operating time and technical performances of greases.

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Section 5 –Systems Subsystems and Control in Aeronautics

(in alphabetical order of the first author)

Study on commutation of power supplies used in a solar UAV

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Abstract: This study deals with the practical way in which a photovoltaic system implemented on the structure of a UAV could ensure the charging of the battery and the supply of electricity to the consumers installed on board. The research work resulted in the design and construction of a model aircraft with a wingspan of 150 cm, on the wings of which a system composed of ten solar cells was integrated, capable of generating a total power of 34.5 W, under normal conditions of exposure to solar radiation. The results obtained highlighted the premises of an analysis of the transient effects of electric current, observed during commutation of power supplies. By means of the experiment presented in this paper, some aspects that can negatively influence the in-flight operation of a solar UAV were noticed. The conclusions aim to identify a technical solution to mitigate the risks encountered during the commutation of the two power supplies, and to guarantee a constant supply of the necessary electricity to consumers throughout the flight of a solar UAV.

Key Words: human factors, safety, pilots, flight simulator, eye tracking, heatmap, ECG, HPE

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Visual based GNC system from prototype to flight software

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Abstract: Juventas is a 6U CubeSat which is part of HERA planetary defense mission and takes advantage of an innovative visual based guidance, navigation and control (GNC) system to perform autonomous navigation in the proximity of the Didymain system. The GNC system is designed to ensure safe navigation in the harsh and unpredictable environment of deep space and finally to take more risks by landing on the surface of Dimorphos. To achieve a qualitative software (SW) product, a dedicated procedure of SW lifecycle is developed by starting with GNC and image processing design, which concludes with the final embedded system that will perform the visual navigation task. A Design, Development, Verification and Validation (DDVV) approach is developed to achieve the flight software: model in the loop (MIL), autocoding, software in the loop (SIL) and finally processor in the loop (PIL). The DDVV is developed by having as guideline the ECSS standards for SW. The flight software reaches maturity by performing dynamic/static code analysis and code coverage. To ensure an optimal process, a waterfall life-cycle is considered, where dedicated MIL, SIL and PIL testbenches are developed to fully support the activity and to reduce to minimum the development costs.

Key Words: guidance navigation and control, visual navigation, model in the loop, autocoding, software in the loop, processor in the loop, flight software

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Actuator fault reconstruction using FDI system based on sliding mode observers

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Abstract: Interplanetary space missions require spacecraft autonomy in order to fulfill the mission objective. The fault detection and isolation (FDI) system increase the level of autonomy and can ensure the safety of the spacecraft by detecting and isolating possible faults before becoming critical. The proposed FDI system is based on an innovative bank of SMOs (sliding mode observers), designed for different fault scenarios cases. The FDI system design aims to detect and isolate actuators and measurement units' faults used by the satellite control system and considers the nonlinear model of the satellite dynamics. This approach gives the possibility of fault reconstruction based on the information provided by an equivalent injection signal, allowing to reconstruct external perturbances and faults. The SMO chattering phenomenon is avoided by using the pseudo-sliding function, being a linear approximation of the signum function, which gives the possibility of using the equivalent injection signal for fault reconstruction purposes. The proposed fault reconstruction methodology is illustrated by a case study for a 6U Cubesat.

Key Words: fault reconstruction, nonlinear spacecraft dynamics, sliding mode observers, fault detection and isolation, chattering, pseudo-sliding, equivalent injection signal, sliding mode observers bank

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Calculation of steering system parameters of a military training aircraft

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Abstract: The mechanical-hydraulic steering system of a military training aircraft is a technical problem for specialized engineers and it must be investigated and solved in a scientific manner using theoretical knowledge, calculus programs such as Mathcad, and CAD applications for design such as CATIA V5 which allows the preservation of practical experience and favors its dissemination for future similar calculation. The scope of this calculus is to demonstrate that the active moment developed by the two hydraulic cylinders is always bigger than the resisting moment opposing the steering action of the nose landing gear wheel generated by the frictional forces between the wheel and the running way.

Key Words: mechanical-hydraulic steering system, calculation of the parameters, military training aircraft

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Section 5.1 – Workshop "Automatic LAnding on MObile PLATform (ALAMOPLAT)"

(in alphabetical order of the first author)

ALAMOPLAT Robotic System – a facility for RvD Simulation, Tests and Verification. Results and future development

Achim IONIȚĂ*,[1], Mihai TUDOSE*,[2]

Abstract: ALAMOPLAT Robotic System located at the INCAS – Maneciu Center is a robotics facility based on SIL/HIL (software-in-the-loop/hardware-in-the-loop) simulator for simulation of autonomous aerospace vehicle missions. Software (e.g. navigation and control) as well as hardware (camera, laser altimeter, INS) or docking tools (docking/berthing) can be tested and verified. The facility consists of two robotic manipulators and a Stewart platform with each six degree of freedom, a linear slide of 22 m length on which one robot can be moved in laboratory and a computer-based monitoring and control system. ALAMOPLAT allows for real time simulation of the rendezvous and docking (or approach and lading) processes between two mobile platforms. These are the most critical phases of aerospace vehicle nissions.

Key Words: autonomous process, robotic system, rendeavous/docking, VTOL, SIL/HIL simulation nonlinear control synthesis

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Use of robotic system for SIL/HIL simulation of an aerospace vehicle approach on a mobile platform

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Abstract: One of the stages of the flight of an air vehicle is represented by rendezvous and docking process, of interest in this paper is the autonomous approach to a mobile platform. A nonlinear model for a TWQH dynamics in the form suited for backstepping control design is designed to stabilize the mobile system as well as the inertia measurement of the flying vehicle. For this purpose, real-time experimental simulations are carried out using ALAMOPLAT Robotic System located at the INCAS – Măneciu Center. This includes the ABB 7600 Robot, which will simulate the movement of the flying vehicle, and the Stewart Platform, which will simulate the mobile platform. In this study, a verification and validation of the numerical simulations in MATLAB based on the nonlinear backstepping control method will be conducted. Also, the two robotic equipment are interconnected using a GPS sensor to determine the position, and a IMU sensor that offers a set of linear and angular speeds and accelerations.

Key Words: backstepping, real-time numerical simulations, autonomous approach, GPS, IMU

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Autonomous landing of a mobile air vehicle on a moving target

Sandra NICHIFOR*,[1], Florin COSTACHE*,[1], Nicolae APOSTOLESCU[2], Mihai TUDOSE[2], Daniel VIȘAN[1], Achim IONIȚĂ[1]

Abstract: The present work aims to carry out a comparative study of the numerical results in both offline and online environment, obtained during the tests of the autonomous landing maneuver of a flying vehicle on a Stewart platform. It is used a TWQH dynamic model with a backstepping controller able to achieve a safe and precise landing on arbitrary moving target. The results of the experiment concerns locating the mobile platform using the laser-altimeter sensor, which estimates the online position of the measurement of relative distance between the flying vehicle and the platform, and determining the vertical trajectory based on the data provided by the IMU sensor, in particular the speed, the acceleration and the attitude angles of the flying vehicle. Comparision simulation and experimental results are presented to validate the performance of the proposed configuration. This application will be developed within the robotic laboratory - INCAS Măneciu.

Key Words: robotic platforms, offline and online environment, autonomous landing, laser-altimeter sensor, attitude angles

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Software solution for Operational Monitoring and Control (OMC) of Robotic System on INCAS – Maneciu platform

Nicolae APOSTOLESCU*,[2], Achim IONIȚĂ*,[1]

Abstract: The ALAMOPLAT facility has been developed to provide the entire real time simulation with special focus on rendezvous/docking (approach/landing) airspace vehicle phases. The OMC is a Windows computer and the interface between operator and facility. A simulation can be run either with real hardware or in simulation mode. The status of the simulation can be observed with different tools. With COM display, several numerical values of the facility and robots can be displayed. Apart of the simulation the OMC operator continuous check the safety state of the robots during simulation. For this purpose, a tool called Safety tool is developed. The location and the status of all emergency stop button are highlighted. Finally, errors occurring the robots and the status Power on/off are also included in the safety tool.

Key Words: monitoring/control tool, robotic system, Stewart platform, safety tool, GUI, MATLAB and C++ codes, Robot Studio, robot synchronous

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Section 6 – Experimental Investigations in Aerospace Sciences

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Analysis of the effects of electrostatic field interaction with photovoltaic cells used to power a solar UAV

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Abstract: Research into the development of photovoltaic sources is making valuable contributions to new aerospace applications. The current global trend has a well-defined direction, towards the use of a greater percentage of green energy, embodied in the concept of "Green energy", in both terrestrial and aerial applications. This paper highlights the possibility of developing new systems to supply electricity to consumers on board a UAV using photovoltaic cells.
The main element of this study is the analysis of the effects resulting from the interaction of the electrostatic field with the photovoltaic cells, mounted on the wings of a UAV, under the influence of different values of solar radiation. In order to validate the hypothesis proposed in this study, an experiment was carried out in which a photovoltaic structure, integrated on the surface of a NACA 0012 airfoil, was exposed to the electrostatic field produced by a Van der Graaff generator. The results obtained show the appearance of an electrical voltage, additional to that generated by the photovoltaic system and independent of the intensity of the light radiation. Contextually, the applicability of the results obtained is materialized by the realization of photovoltaic systems capable of generating electricity independently of the existence of a light source.

Key Words: photovoltaic cells, model aircraft, airplane, wing, electric field, electrostatic field, electric voltage

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Opportunities at ELI-NP: Materials testing under the influence of high energy ionizing radiation

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Abstract: Once the present commissioning phase of the ELI-NP facility (in Magurele, Romania) will reach the end, the experimental areas will be available for research activities dedicated to fundamental and applied physics. Among the foreseen directions, a special place is dedicated to materials science studies and radiobiology experiments.

The laser-driven ionizing radiation has the required attributes to well reproduce the cosmic radiation in a ground-based laboratory: high energetic and broadband spectrum, multi-particle components. Although the flexibility of the experimental setups provides a high degree of tunability: single or multiple exposures, weights for different components, etc., there are still challenges which have to be addressed in the near future but, in any case, this environment represents a step forward with respect to classical accelerators. In our contribution we review the opportunities provided by ELI-NP for experiments on biological samples and materials with relevance for space applications. As a preliminary estimation of the foreseen parameters for sample irradiations, we present results obtained during the commissioning experiments with laser accelerated electrons and protons and we show the foreseen ways for development of the experimental setups.

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On the evaluation of turbulence parameters in the wind tunnel

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Abstract: Commercial aircraft and aviation, in general, face in flight the appearance of turbulent fields, which requires immediate changes in airplane trajectory in order to avoid as much as possible the danger to aircraft and passengers. Up until 2010, the International Civil Aviation Organization (ICAO) [1] considered AIREPs (an automated report of weather conditions encountered during flight) and PIREPs (pilot report about weather conditions encountered during flight) a turbulence intensity indicator. In order to avoid the subjectivity of those reports, which were dependent on the type of aircraft, air speed, pilot experience, the reaction of the crew and the movement of unsecured objects around the cabin, an in situ turbulence reporting algorithm based on ICAO standard EDR index (eddy dissipation rate) has been considered [2]. The EDR index is defined as the cubic root of the turbulence energy per unit time and mass [3]. In turbulent motion there is a cascading process, through which kinetic energy is transferred from the larger eddies to the lowest eddies, where it dissipates in heat, and the energy transfer rate from the larger eddies to a smaller ones is the same as the rate of energy dissipation in heat in the smallest eddies. This is how the process of dissipation and decay of fractal-generated turbulence takes place. The theoretical background is based on the Kolmogorov approach [4], [5]. The determination of the order of magnitude of the energy dissipation during the turbulent motion has as reference the procedure described in [6]. The intensity of turbulence will be identified in the INCAS subsonic wind tunnel (WT). The turbulence is produced by a passive turbulence generator [7]. A Big Data volume is in this way obtained and becomes the basis of statistical calculations for turbulence diagnosis and forecasting.

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Experimental research of hydraulic cylinder with the built-in throttle for steering

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Abstract: This paper presents the experimental research method of a hydraulic cylinder used for steering system of a military training aircraft. The actuation of a mechanical-hydraulic steering system is made by the two interchangeable hydraulic cylinders acting in tandem to rotate the mobile subassembly that contains the wheel of the front landing gear. Each hydraulic cylinder is designed with a built-in throttle with the purpose of equalizing the movement speed of the hydraulic cylinder rod in both directions of movement (extension and compression). During the experiments, three constructive variants of the built-in throttle will be used to obtain the optimal constructive variant of the built-in throttle.

Key Words: experimental research method, hydraulic cylinder, built-in throttle, steering system, military training aircraft

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Experimental Investigations of Free Air Turbulence Using Low Mass, Data Linked UAVs

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Abstract: Practical investigations of turbulence are as old as aviation itself and this fact is a testament of the importance of understanding adverse atmospheric phenomena and their impact on flight safety and aircraft maintenance. Avoiding turbulence meant both avoiding loss of life and equipment and increasing life expectancy of airframes. While dynamic effects of turbulence are reduced on large scale aircraft, the stress and strain on their structure increases significantly. Much smaller craft are inevitably rattled or pushed around in large air disturbances but their structures tend to be stiffer due to scaling effects. Normalized efforts on their structures tend to be reduced but basic flight safety prohibits flight of low mass aircraft in severe weather-so much turbulence data is remotely collected using ground or space-based instrumentation via meteorological satellite observation. This paper aims to describe a concept of exploring turbulence using very small and data linked disposable UAVs that can be injected in suspected or observed turbulent regions of the atmosphere and collect essential data to help meteorologists and air safety personnel predict and avoid dangerous flight conditions. Out of all the dangers of turbulence, clear-air turbulence or CAT for short is the most dangerous as it is not completely understood and it remains hard to detect.

Key Words: experimental investigation, clear air turbulence, data linked UAVs

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Gamma irradiation facility for evaluation of space radiation effects on biological systems

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Abstract: In this paper is described a new facility for evaluating the effects induced by the cosmic rays on biological samples with application in space researches.
In accordance with the characteristics of the future radiation source of ELI-NP Experimental Area E5 a gamma irradiation system was designed and achieved with the following features:

- Gamma radiation fields, emitted by two ^{60}Co sources with 4317 TBq (117 Ci), and 2760 TBq (75 Ci) activities.
- Horizontal irradiation axis with conical distribution (~30 degrees angle)
- Shielding, collimator and shutter made of lead
- Orbital shaker HS 270 type with adjustable speed and timer
- Biological sample support made extruded polystyrene with 23.2 g/l density positioned at over 10 cm from the orbital shaker (to reduce the gamma retro-reflection phenomena)
- Thermostat mantle coupled at an AU 01Thermostat
- Dose rate can be adjusted in according to: source activity, distance between source and samples, and attenuation of the radiation field in lead layers with varying thicknesses (0.1 Gy/h …. 50 Gy/h).

The new irradiator was put in the hot cells within the IFIN HH DRMR and used in radiobiology studies in partnership with INCD V Babes and ELI NP.

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Section 7 – ATS and full Automation ATM

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Enhancing the performance of the Primary Surveillance Radar using Multilateration

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Abstract: One way to improve the measurements of the PSR (Primary Surveillance Radar) is utilizing the cinematic model of the aircraft in a Kalman filter. Another newly developed method would be to implement multilateration using a large number of ground-based ADS-B (Automatic Dependent Surveillance-Broadcast) receivers. Originating in airport surveillance, multilateration grew to become the primary system for ATM (Air Traffic Management) in airspaces that lack PSR coverage. As each of the systems have their own advantages and limitations, we propose an evaluation of an alternative approach using the data from multiple ADS-B receiver to implement data fusion algorithm between PSR acquired position and MLAT (Multilateration) estimated position. From the numerous ways of implementing data fusion, we chose to analyze two possible solutions: the direct fusion of the two available positions given to us by the two systems using a traditional Kalman Filter and a linearization approach for the multilateration solution which do not require position computation. In both cases, these will improve the Kalman filter and lower the position estimation errors. The evaluation takes into consideration the possible sources of inaccuracies and provides sensibility analyses in regards to the number and positioning of ADS-B receivers involved in multilateration. This paper will conclude with a discussion about the necessary computing power for the two implementations.

Key Words: Primary Surveillance Radar (PSR), Multilateration (MLAT), Automatic Dependent Surveillance-Broadcast (ADS-B), Kalman Filter, Air Traffic Management (ATM)

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Section 8 – Management in aerospace activities

(in alphabetical order of the first author)

Contractual Requirements Review and Management

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Abstract: This article presents contractual requirements review likes an element of a Quality Management System (SR EN 9100:2018), which requires the organization to conduct requirements reviews at various stages of the product realization lifecycle. Proper conduct of a review and management of requirements will enhance overall supply chain performance with regards to On-Time-On-Quality Delivery (OTOQD).

Key Words: On-Time-On-Quality Delivery (OTOQD, types of requirements, product-related-requirements

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Considerations regarding the risk of using counterfeit products in the aerospace industry

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Abstract: This paper aims to increase the level of awareness regarding the risk of using counterfeit parts in the aerospace industry. Manufacturing and selling counterfeit parts is a challenge that almost every business faces and that has an impact on retailers, distributors, and producers. Contrary to other businesses, counterfeiting could be fatal in the aerospace, defense, and automotive sectors. The risk of receiving counterfeit parts or assemblies with counterfeit parts will vary depending on the organization's role and position within the supply chain. The risk increases with the number of supply chain intermediaries (such as sub-tiers, distributors, customers, services, etc.) that incorporate parts into products or assemblies.

Key Words: counterfeit parts, risk, supply chain, SR EN 9100:2018/AS 9100D

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Workshop "Propulsion systems with detonation" COMOTI Bucharest

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Review of pulsed detonation engine aerodynamic systems

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Abstract: Current propulsion technologies are at their development peak with little room for improvement, which makes detonative propulsion a feasible alternative for both aerospace propulsion. The latter has increased efficiency and performances making it more prized than other architectures, such as gas turbines or rocket engines. In addition, the detonation engine targets to meet zero carbon emissions, since Hydrogen is a suitable fuel candidate, liable for detonation. Furthermore, the specific impulse of the detonation combustors has higher theoretical specific impulse than conventional rocket engines. This paper presents theoretical and experimental development of the pulsed detonation engine (PDE) concept and its aerodynamic system. The PDE works under an unsteady cyclic process, where a higher operating frequency means higher performances. To better understand the impact of the aerodynamic system on the performances of the PDE, this research targets to make an in-depth review from the early systems such as mechanical valves PDEs, to state of the art, self-sustained aerodynamic systems. Moreover, the analysis also incorporates the transition from mechanical mixture control system to Hartmann-Springer oscillators, which represent a passive control method of the aerodynamics to attain higher frequency cycle, with a theoretical maximum of 1000 Hz.

Key Words: Detonation Engines, High-frequency oscillations, Aerodynamics, Hydrogen

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Detonation wave characterization in pulsed detonation engine

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Abstract: National and international organisations, like the European Commission, agreed that the industrial and household energy consumers have to reduce their carbon emissions, so the endeavour for greener and more efficient technologies are required. Detonation combustion is one of the novel technologies proposed in the last decades, due to higher efficiency compared to conventional deflagration. Not only Hydrogen has zero-carbon footprint, but it is also prone to detonation, both properties being advantageous for detonation-based combustion. High performance constant volume thermodynamic cycle requires high detonation frequency which is linked to very short cycles in the order of milliseconds. Under these operating conditions, the system configuration is of utmost importance for reliability and lifecycle criteria. Both active and passive flow control strategies for both the mixing process and DDT for flame front acceleration must be carefully investigated. This paper illustrates the aerodynamics of detonative combustion wave, namely the coupling of the flame front with the shock wave, for a pulsed detonation engine fuelled with Hydrogen-air mixture. Schlieren Visualisation Technique is deployed at the exhaust pipe of the engine, to show the configuration of the outlet flow field and the specific cycle behaviour of the combustor.

Key Words: Detonation Combustion, DDT, Schlieren Visualisation Technique, High-speed thermodynamics

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A review of detonation based combustion architectures for modern propulsion systems

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Abstract: Propulsion system with supersonic internal flow received special attention in recent studies, due to their potential of increasing gas turbines cycle efficiency and overcome their limitation. There are several architectures this requirement, however, the keen focus of this work is on pressure gain combustors (PGC). The advantage of this propulsion system is the pressure gain heat addition, which enables higher cycle efficiencies and grater energy release rate, at high cycle frequencies. This paper covers an extensive background of the research activity of pressure gain technology solutions, with emphasis on key geometrical features and main physical parameters that influence the transition to the detonation regime and its self-sustenability. The main objective is to acquire guidelines regarding the experimental research of such a propulsive architecture. A comparison between detonation engines with gas turbines engines used in the aerospace field, is also provided.

Key Words: Pressure Gain Combustion, Detonation Wave, System Architecture, DDT

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Analyzes regarding parameters of aviation fuels use on jet engines

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Abstract: The dynamics of combustion in combustor of aviation engines requires thermo-chemical approaches and combustion dynamics as well as the geometry of the volume where combustion takes place. The properties of the fuels determine the quality of the combustion process and implicitly the performance of the jet engine. The optimal heterogeneous combustion process of an aviation fuel is ensured by a stoichiometric ratio (fuel/air), a combustion temperature and a maximum loading degree of the combustion chamber (combustor).
The article includes a numerical analysis that highlights the influence of fuel quality and the combustion process on the performance of the propulsion system, analysis instrumented with Gasturb software

Key Words: combustor, jet petrol, Gasturb, numerical analysis

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Parametric analyzes of jet engines combustion chambers

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Abstract: The combustion performance of a combustor influenced by two groups of parameters: atmospheric and operational. Depending on the constructive or operating limitations, a series of optimizations are adopted based on pre-design parametric analyzes that can provide numerical data regarding the operating intervals of the combustion chamber in particular and of the jet engine in general.
The article includes a series of parametric analyzes on the combustion process, with the help of Gasturb, to determine the degree of influence of the relevant combustion parameters on the performance of jet engines.

Key Words: combustor, numerical analyzes, combustion parameters, Gasturb

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