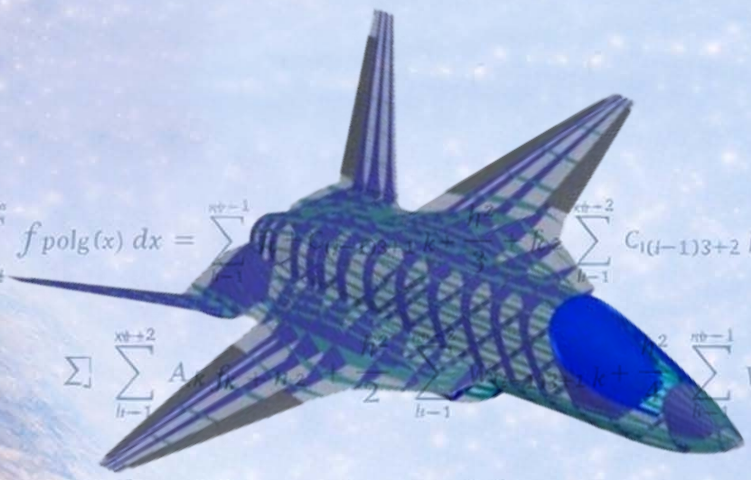
ISCO
INCAS SPRING CONFERENCE

INCAS
National Institute for Aerospace Research "Elie Carafoli"

1st INCAS Spring Conference

"ISCO 2026"

07 MAY 2026 | BUCHAREST, ROMANIA



$$\int_{\omega t}^{\infty} f\,\mathrm{polg}(x)\,dx = \sum_{h=1}^{\infty} C_{i(i-1)3+2}\,h\,F_n = \ldots$$

$$\sum \sum_{h=1}^{\infty} A_{jk} \sum_{h=1}^{\infty} \frac{\tau^{T}\text{-}2}{|2|} \sum_{h=1}^{\infty} k + \frac{h^2}{4} \sum_{h=1}^{\infty} W_{(i-1)3+2}\,k\,F_k = \ldots$$

$$\sum \sum_{h=1}^{\infty} A_{jk} \sum_{h=1}^{\infty} \frac{\tau^{T}\text{-}2}{|2|} \sum_{h=1}^{\infty} k + \frac{h^2}{4} \sum_{h=1}^{\infty} W_{(i-1)3+2}\,k\,(f_{k+1} - f_k) = \ldots$$

$$Trick \rightarrow \sum_{h=1}^{\infty} y_{n+1} = y_n + \sum_{h=1}^{\infty} d_n f_{n+1-np+k}$$

Book of Abstracts

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BOOK OF ABSTRACTS

INCAS Spring Conference (ISCO)
is a newly established scientific conference organized by the INCAS Scientific Council

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Publisher:

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Conference Topics

1 – Low Fidelity and Light computational models applied in Aerospace

2 – Advanced Numerical simulation and optimization

3 – Applied Aerodynamics

4 – Artificial Intelligence in Aerospace at all levels

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PROGRAM

9.45–10.00	**Registration of participants and welcome coffee**	
Time (CET)	**"ELIE CARAFOLI" Amphitheatre**	
10.00–10.10	**OPENING CEREMONY** Welcome speech Dr. Fiz. **Adriana STEFAN**, President & CEO, INCAS – National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania Dr. eng. **Mihai-Victor PRICOP,** Vice President of the Scientific Council of the 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, National University of Science and Technology POLITEHNICA Bucharest	
Keynote Speaker **10.10–10.25**	**Chairman: Dr. Eng. Mihai Victor PRICOP** (INCAS) *Playing with numerical methods and 人工 in aerospace*	
10.25–10.40	**Marius-Daniel MARINESCU**[*,1], Stefan-Florin GRIGORE[1], Teodor-Andrei CRISTEA[1], Florin TACHE[1], Lorenzo CERCOS PITA[2], Samuel MUNOZ-CABALLERO[2], Germán MORENO ESCUDERO[2] [1]Indra Space, Deimos Space S.R.L., Romania [2]Indra Space, Deimos Engineering and Systems S.L.U., Spain	*Modelling of Real Time Units in the Verification and Validation Process of Satellite Systems*
10.40–10.55	**Gabriel GRAUR**[*,1], Andrei-Filip COJOCARU[1], Andrei-Alexandru LAPUSNEANU[1], Alina-Georgia IONITA[1], Traian-Andrei ANTOHI[1], Florin TACHE[1], João P. BELFO[2], José VASCONCELOS, Vicente FERNANDEZ[3], Alfredo AGENJO[4], Salvador LLORENTE[4], Marjorie VALLEJO[4], Alberto IBERNÓN[4] [1]Indra Space, Deimos Space S.R.L., Romania [2]Indra Space, Deimos Engenharia S.A., Portugal [3]Indra Space, Deimos Engineering and Systems S.L.U., Spain [4]SENER Aeroespacial, Spain	*Modelling And Simulation Of The Space Rider Re-Entry And Landing Phases*
10.55–11.10	**BENCZE Andrei**[*,1] [1]Transilvania University of Brașov, Romania	*AI in Aerospace: Present and Future*
11.10–11.25	**Claudiu IGNAT**[1], Grigore CICAN[2,3] and Daniel MARIUTA[*,1] [1]Military Technical Academy, Romania [2]Romanian Research and Development Institute for Gas Turbines COMOTI, Romania	*Low-order thrust and torque prediction model versus CFD simulation for UAV propellers generated with a parametric Python-CATIA workflow*
11.25–11.40	**Rares Alexandru SOCEA**[*,1], Stefan Cristian CODREANU[1], George-Razvan BUICAN[1] [1]Transilvania University of Brașov, Romania	*ASPECTS REGARDING THE DEVELOPMENT OF ATMOSPHERIC IONIC PROPULSION SYSTEMS*
11.40–11.55	**Stefan Dorian CATALIN**[*,1], George-Razvan BUICAN[1] [1]Transilvania University of Brașov, Romania	*DESIGN AND ANALYSIS OF A TEST BENCH FOR PROPELLER MOTOR CALIBRATION*
11.55–12.30	***Coffee break***	

12.30–12.45	**Stefan Cristian CODREANU*,1,** George-Razvan BUICAN**1,** Traian Angel HUMINIC**1** [1]Transilvania University of Brașov, Romania	*LIGHT COMPUTATIONAL MODEL OF AN ATMOSPHERIC IONIC THRUSTER*
12.45–13.00	**Larisa-Anda Stroe*,1,** Daniel-Eugeniu Crunteanu[1], Mihail Botan[2], Adriana Stefan[2], George-Catalin Cristea[2], Alina Dragomirescu[2] [1]National University of Science and Technology POLITEHNICA, Romania [2]INCAS, Romania	*Differential Scanning Calorimetry data driven analyses in prediction of Heat Deflection Temperature for bio-based epoxy composites*
13.00–13.15	**Andreea-Catalina LAMATIC*,1**, Andrei NENCIU[1] [1]INCAS, Romania	*The effects of adherent geometry on the peeling behavior of adhesive tapes*
13.15–13.30	**Mihaita-Gilbert STOICAN*,1,2**, Theodor-Andrei DRAGHICI[1,2], Ionut BUNESCU[1,2], Mihai-Victor PRICOP[1,2], Mihai-Vladut HOTHAZIE**1,2,** Mara-Florina NEGOITA[1,2] [1]INCAS, Romania [2]National University of Science and Technology POLITEHNICA, Romania	*Assessment of Static Divergence and Flutter Characteristics for a Fin Configuration*
13.30–13.45	**Mihai-Vladut HOTHAZIE*,1,2**, Mihai-Victor PRICOP[1,2], Daniel-Eugeniu CRUNTEANU[2], Ionut BUNESCU[1,2], Mara-Florina NEGOITA[1,2], Theodor-Andrei DRAGHICI[1,2] [1]INCAS, Romania [2]National University of Science and Technology POLITEHNICA, Romania	*Modeling of Airfoil Ice Accretion Based on Aerodynamic Flow Fields and Droplet Collection*
13.45–14.00	**Mara-Florina NEGOITA*,1,2 ,** Alina BOGOI**2,** Mihai-Vladut HOTHAZIE**1,2,** Ionut BUNESCU**1,2,** Andra-Ana-Maria GHEORGHIU**1** [1]INCAS, Romania [2]National University of Science and Technology POLITEHNICA, Romania	*Deterministic Optimization of a Single-sloted Flap Using an Automated CFD Methodology*
14.00–14.15	**Andra-Ana-Maria GHEORGHIU*,1**, Ionut BUNESCU[1,2], Mihai-Vladut HOTHAZIE[1,2], Mara-Florina NEGOITA[1,2], Mihai-Victor PRICOP[1,2] [1]INCAS, Romania [2]National University of Science and Technology POLITEHNICA, Romania	*Mathematical modelling of helicopter flight performance*
14.15–14.30	Octavian-Mircea CRISAN[1], Alexandru PASULA[1], Ionuț BUNESCU[2,3], Mihai-Vladut HOTHAZIE[2,3], **Mihai-Victor PRICOP*,2,3,** Mihaita-Gilbert STOICAN[2,3], Bogdan RUSU[2], Dumitru PEPELEA[2] **1**ATNOM, Oradea [2]INCAS, Romania [3]National University of Science and Technology POLITEHNICA, Romania	*Aerodynamic and Flight Performance Analysis of an Electrically Converted Light Helicopter: Clean and Podded Configurations*
Time (CET)	**"NICOLAE TIPEI" Amphitheatre**	
	***Co-Chairmans: Ionut BUNESCU** (INCAS), **Vladut-Mihai HOTHAZIE** (INCAS)*	
10.25–10.40	**Tiberiu Adrian SALAORU*,1**, Vlad TUDORACHE PROHNITCHI[1,2], Marius POP[1], Adina Diana DOBRIN[3] [1]INCAS, Romania [2]Reykjavik University, Iceland [3]Faculty of Physics, University of Bucharest, Romania	*Optimization of the photovoltaic and wind turbine electrical power distribution and storage*
10.40–10.55	**Cristian OGNERU*,1**, Silviu RAILEANU[2] [1]INCAS, Romania	*Computer Vision Based Guidance and Navigation for Autonomous Aerial Vehicles: A Systematic Survey*

	[2]National University of Science and Technology POLITEHNICA, Romania	
10.[55]–11.[10]	Ionuț-Ovidiu BRINZA*[,1], **Livia-Jeanina PANAIT*[,1]**, Oana-Iuliana POPESCU[1], Radu-Ștefan COPAESCU[1], Ștefan VLASIE[1], Catalin-Sever MOISOIU[1], Bogdan-Cristian VASILESCU[1] [1]INCAS, Romania	*Space Rider Drop Test (SRDT)- DLTM AND MGSE DESIGN, MANUFACTURING AND TESTING*
11.[10]–11.[25]	**Mihaela DAVIDESCU*[,1]**, Marina ANDREI[1], Cristiana JIDOVU[1], Tudor GAGIU[1], Tiberiu Adrian SALAORU[1], Dana-Maria LEPĂDATU[1] [1]INCAS, Romania	*Design of a high-pressure test bench for air jets simulation experiments for crew escape system thrusters*
11.[25]–11.[40]	**Catalin IORDACHE[1]**, Alexandru DOBRESCU[1], Catalin NAE*[,1] [1]INCAS, Romania	*XCAS – Conflict Awareness System for Ground and Airborne Operations*
11.[40]–11.[55]	**Ana-Maria BORDEI*[,1],** Mihnea DITEI[1], Sandra-Elena NICHIFOR[1], Aida Maria IONEL-FAKHOURI[1] and Catalin NAE[1] [1]INCAS, Romania	*Real-Time Conflict Detection and Intercept Planning for ATC Simulation*
11.[55]–12.[30]	***Coffee break***	
12.[30]–12.[45]	**Sandra NICHIFOR*[,1],** Achim IONITA[1] [1]INCAS, Romania	*Gust Alleviation Control with delay – a study case*
12.[45]–13.[00]	**Andrei AVRAMESCU*[,1]** [1]INCAS, Romania	*Development and Validation of a Portable Ground Control Station for UAV Applications*
13.[00]–13.[15]	**Khaled HACHEM*[,1]**, Andrei ION[1] [1]INCAS, Romania	*Digital Avionics Display for ArduPilot*
13.[15]–13.[30]	**Tudor GAGIU*[,1]** [1]INCAS, Romania	*Design of an Electromechanical Actuation System for Optional Autopilot Integration on a Ultralight Aircraft*
13.[30]–13.[45]	Tudor Gheorma[1], **Khaled Hachem*[,1]** [1]INCAS, Romania	*Development of a General-Purpose Flight Controller*
13.[45]–14.[00]	**Ionut BUNESCU*[,1,2]**, Mihai-Victor PRICOP[1,2], Mihaita-Gilbert STOICAN[1,2], Mihai-Vladut HOTHAZIE[1,2], Mara-Florina NEGOITA[1,2], Andra-Ana-Maria GHEORGHIU[1], Theodor-Andrei DRAGHICI[1,2] [1]National University of Science and Technology POLITEHNICA, Romania [2]INCAS, Romania	*Recent Developments in Aerodynamic Damping Test Rigs at the INCAS Trisonic Wind Tunnel*
14.[00]-14.[15]	**Theodor-Andrei DRAGHICI*[1,2]**, Daniel-Eugeniu CRUNȚEANU [2], Ionut BUNESCU [1,2], Mihaita-Gilbert STOICAN [1,2], Mihai-Vladut HOTHAZIE [1,2], Mihai-Victor PRICOP [1,2] [1]National University of Science and Technology POLITEHNICA, Romania [2]INCAS, Romania	*Uncertainty Propagation for Wind Tunnel Data Post-Processing: Application to a Reference Test Model*
14.[15]-14.[30]	**Octavian NISTOR*[,1]**, Cristian MOISEI[1], Adrian GAZ[1] [1]INCAS, Romania	*Selection of Critical Load Cases for Static Testing of a Rotorcraft Fuselage Upper Deck Specimen*
14.[30]–14.[45]	**CLOSING CEREMONY**	

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Keynote Speaker	***Playing with numerical methods and 人工 in aerospace*** **Dr. Eng. Mihai Victor PRICOP** (INCAS)

Modelling of Real Time Units in the Verification and Validation Process of Satellite Systems

Marius-Daniel MARINESCU*,[1],
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Abstract: *Verification and Validation (V&V) methodologies are essential to ensure the correct operations of control algorithms of the embedded software during a satellite mission. This paper addresses a critical aspect of aerospace systems development, namely the process of testing the flight software during the V&V campaign for functional qualification on ground.*
Having as reference the European Attitude Determination and Control System (E-ADCS) for nano satellites and small satellites up to 80 kg, the study investigates the integration of two main testing stages, Model-in-the-Loop (MIL) and Processor-in-the-Loop (PIL) within a performance validation framework.
The PIL phase is described by the exchange of telemetry (TM) and telecommand (TC) messages between the onboard computer (OBC) and a computer acting as a simulated ground station. This phase enables the validation of the flight software that is loaded and runs on the OBC.
The MIL phase is implemented using a Speedgoat machine, which supports the real-time execution of Simulink-based models of sensors and actuators, running our custom-made Attitude and Orbit Control Systems (AOCS) algorithms. Communication with the models is achieved by writing commands inputs through MATLAB-based test scripts and reading outputs via dedicated interface adapters that enable the interaction between the PC and Speedgoat machine.
The integration phase is described by the relation between PC, OBC and Speedgoat (End-to-End testing) where the validation takes place for both the embedded software and AOCS algorithms with the sensors and actuators in the loop.
This framework contributes to improving the robustness of the E-ADCS product by enabling early detection of integration issues and comprehensive system-level validation. At this stage, it provides significantly greater visibility and debugging capability compared to later testing environments (e.g. flat-sat) that involve physical units only.
The work in this paper is part of an ESA Incubed co-financed project led by Indra Space, with Skylabs as a consortium partner for providing the OBC.

Key Words: *Real Time Systems, Matlab, Simulink, Speedgoat, Model-in-the-Loop, Processor-in-the-loop*

Modelling And Simulation Of The Space Rider Re-Entry And Landing Phases

Gabriel GRAUR*,[1], Andrei-Filip COJOCARU[1], Andrei-Alexandru LAPUSNEANU[1], Alina-Georgia IONITA[1], Traian-Andrei ANTOHI[1], Florin TACHE[1], João P. BELFO[2], José VASCONCELOS, Vicente FERNANDEZ[3], Alfredo AGENJO[4], Salvador LLORENTE[4], Marjorie VALLEJO[4], Alberto IBERNÓN[4]

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Abstract: *The design and Verification &Validation (V&V) of Guidance, Navigation, and Control (GNC) algorithms for reusable re-entry space vehicles represent one of the most challenging aspects of modern aerospace engineering. One of these challenges, which is the focus of this paper, is the modelling and simulation of autonomous flight control systems, particularly the high-dynamic transition from orbital de-orbiting to precise landing. Using Europe's Space Rider as a primary reference, the authors examine the development of a robust simulation environment capable of capturing the complex aerodynamic and atmospheric interactions that occur during the re-entry and parafoil descent phases.*
The paper details the Model-in-the-Loop (MIL) architecture used to verify the GNC logic, leading into the results of extensive simulation campaigns that validate the algorithms' ability to compensate for mission dispersions and sensor uncertainties.
The paper presents the results of extensive simulation campaigns that validate the algorithms' ability to compensate for mission dispersions and sensor uncertainties.
This work is the collaborative result of the ESA-led consortium (Thales Alenia Space Italy, SENER Aeroespacial and Indra Space), aiming to provide a reliable representative simulation environment for vehicle qualification. Ultimately, the paper demonstrates how advanced simulation techniques reduce the reliance on costly physical testing while ensuring the safety and precision required for the next generation of reusable space transportation systems.

Key Words: *Modelling, Simulation, GNC Algorithms, Re-entry Vehicles, Space Rider, MIL Validation*

AI in Aerospace: Present and Future

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Abstract: *The integration of artificial intelligence (AI) into aerospace engineering has progressed from a primarily experimental discipline to a critical enabler of advanced design, manufacturing and operational capabilities. This paper examines the current applications of AI across the aerospace field and tries to evaluate its predicted evolution in the foreseeable future.*

At the design level, AI techniques are increasingly employed to enhance multidisciplinary optimization processes. Machine learning models are used for detailed simulations, reducing computational costs and enabling a more extensive exploration of the design space. Applications include aerodynamic shape optimization, structural assessment during the design phase and propulsion system performance modeling. For the moment, these tools are not intended to replace conventional methods but to complement them, especially in early-stage design and rapid prototyping environments.

In manufacturing, AI supports improved process control, defect detection and supply chain management. The adoption of intelligent monitoring systems in composite fabrication and additive manufacturing has contributed to increased reliability and reduced variability in production outcomes. These developments are particularly relevant as aerospace systems incorporate more advanced materials and complex geometries.

Operationally, AI plays a central role in autonomy and decision support systems. Current implementations in unmanned aerial vehicles demonstrate the capability of AI-driven navigation, guidance and control algorithms under constrained and uncertain conditions. In commercial aviation, decision-support tools assist flight crews and ground operators in optimizing routes, fuel consumption and maintenance scheduling. In space applications, onboard autonomy supported by AI is essential for deep-space missions, when communication delays limit ground intervention.

Predictive maintenance has emerged as one of the most mature applications of AI in aerospace. By analyzing large datasets from onboard sensors and maintenance records, machine learning models can identify degradation patterns and estimate remaining useful life of critical components. This approach improves system availability and reduces lifecycle costs, while maintaining compliance with safety requirements.

Despite these advancements, several challenges must be addressed before widespread adoption of AI in safety-critical aerospace systems can be achieved. Certification frameworks remain largely oriented toward classical systems and are not fully adapted to data-driven models. Issues related to model interpretability, robustness under off-nominal conditions and cybersecurity must also be resolved. Furthermore, the integration of AI into legacy systems requires careful consideration of system architecture and human-machine interaction.

Looking ahead, the continued development of AI in aerospace is expected to focus on hybrid modeling techniques, increased onboard autonomy and tighter integration between digital design, manufacturing and operational feedback through digital twin concepts. Progress in these areas will depend on advances in computational resources, data availability and regulatory adaptation.

This paper provides a structured overview of these topics, linking current capabilities with foreseeable developments and identifies key research directions necessary to ensure the safe and effective integration of AI into future aerospace systems.

Key Words: *Artificial Intelligence (AI), aerospace engineering, autonomous systems, predictive maintenance, virtual models*

Low-order thrust and torque prediction model versus CFD simulation for UAV propellers generated with a parametric Python-CATIA workflow

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Abstract: *This paper describes a simplified method for designing and evaluating propellers for small unmanned aerial vehicles (UAVs) during their initial development phase. Acknowledging the necessity of efficient and reliable tools at early stages, the presented approach enables rapid generation of propeller geometries and preliminary aerodynamic assessment prior to the use of higher computational models. The method centers on a parametric workflow that combines automated computer-aided design (CAD) generation via a Python-CATIA interface with a low-order aerodynamic prediction model and computational fluid dynamics (CFD) analysis. By allowing the user to define radial distributions of chord, twist, and aerodynamic profile, the system delivers a computationally efficient means to estimate critical performance metrics, such as thrust and torque, across various operating conditions. Based on the provided distributions, the system generates a geometric CAD. To validate the workflow, two propeller designs are examined, focusing on how geometric variations and different operating conditions modify aerodynamic performance. For each configuration, predictions from the low-order model are compared against results from ANSYS Fluent CFD simulations. This comparative analysis highlights not only the qualitative agreement in performance trends, but also the differences between simplified and high-fidelity modeling approaches. The study further discusses the strengths and limitations of the low- order model, particularly its handling of induced flow, tip losses, three-dimensional effects, and viscous phenomena. Ultimately, the paper demonstrates that the automated Python-CATIA workflow is highly effective for accelerating the process of propeller design and evaluation in the early development of UAV platforms, while CFD remains an essential tool for detailed performance evaluation.*

Key Words: *UAV, propeller, Python-CATIA workflow, parametric CAD generation, low-order aerodynamic model, thrust prediction, torque prediction, CFD analysis*

Aspects Regarding the Development of Atmospheric Ionic Propulsion Systems

Rares Alexandru SOCEA*,[1], Stefan Cristian CODREANU[1], George-Razvan BUICAN[1]

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Abstract: *Electrohydrodynamic propulsion , commonly known as ionic propulsion, represents an unique way of generating thrust through the acceleration of ionized particles in an electric field. A high-voltage electric field ionizes the air particles, primarily diatomic oxygen and nitrogen, producing a mixture of positive ions and free electrons. The positive ions are accelerated towards the collector electrode.*

The first clear laboratory observations of ionic wind generated between high-voltage electrodes studies of corona discharge in gases, where researchers noted that ionization in air produced a measurable airflow between opposite charged electrodes. In 1920, a phenomenon in which asymmetric high-voltage capacitor configurations produced a net thrust due to ionized air motion was observed, later referred to as the Biefeld-Brown effect. In the 1950s, it was observed that thin-wire electrodes under high-voltage produce a strong localized electric field, initiating corona discharge and generating a measurable airflow due to ionized particle motion in air.

This paper analyzes the historical development of ionic propulsion while examining different ionic thruster configurations and their operating principles, with particular emphasis on their structural design, electrode geometry, and the electrohydrodynamic mechanisms responsible for thrust generation.

Design and Analysis of a Test Bench for Propeller Motor Calibration

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Abstract:*Test benches are essential equipment for the experimental validation of aerospace components, allowing the verification of mechanical and functional characteristics before integration into complex assemblies. In the case of propeller motor systems, calibration requires a rigid, stable and adaptable structure capable of supporting different motor–propeller configurations under controlled testing conditions.*
This paper presents the design and analysis of a modular test bench intended for propeller motor calibration. The proposed structure is based on a standardized metallic frame and an adjustable clamping platform, developed and modelled in 3D using Autodesk Fusion 360. After the modelling stage, a finite element analysis is performed to evaluate the mechanical behaviour of the support structure under different loading conditions. The FEM study considers the support without the motor installed, with the motor mounted, and with the motor operating at maximum power. This allows the identification of stress concentrations, deformation levels and critical areas that may influence stiffness, safety and dimensional stability during testing.
The constructive solution enables rapid mounting, positioning and fastening of different motor–propeller configurations using detachable elements, bolted joints and interchangeable subassemblies. The proposed test bench combines mechanical robustness with configurational flexibility and provides an adaptable experimental platform for the calibration, structural verification and preliminary evaluation of propeller motors used in aerospace applications.

Key Words: *propeller motor calibration, modular test bench, finite element analysis, aerospace testing, structural stiffness.*

Light Computational Model of an Atmospheric Ionic Thruster

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Abstract: *The Corona effect is an electric-nature physical phenomenon, which occurs when a high voltage electrode generates an electric field, which is powerful enough to ionize the gas that surrounds it. In the moment, when the intensity of the electric field exceeds the critical intensity of the gas, the gas' molecules are split into positive ions and electrons. This area of poorly ionized plasma, doesn't generate a complete discharge, but it generates a series of micro-discharges, dependent on the geometry of the electrode.*

This field has been studied since the 1900s, when the Drude-Lorentz theory was announced. This theory suggests that metals are made up by positively-charged-ionic cores, among which float the valence electrons. The pioneer of the ionic thruster ideea was Konstantin Țiolkovski, which, at the beginning of the 1910s, suggested that the ionic propulsion thrusters should be used for spatial thruster.

During this paper, we analyse the most influential simulation methods, used in the development of ionic propulsion, taking into consideration, also, the impact that they have had in this area of application.

Differential Scanning Calorimetry data driven analyses in prediction of Heat Deflection Temperature for bio-based epoxy composites

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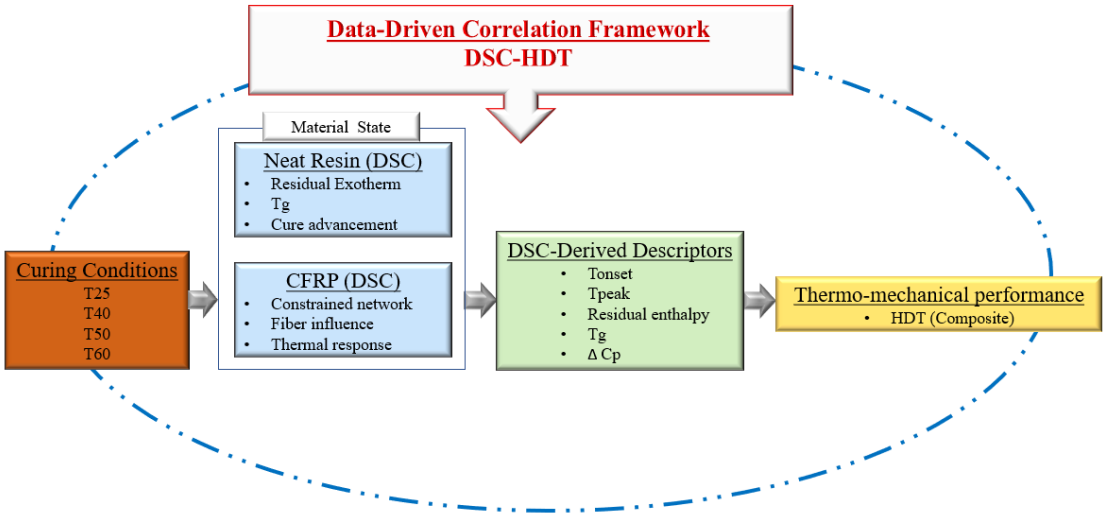
Abstract: *The thermal performance of bio-based carbon-fiber-reinforced polymer (CFRP) composites is strongly dependent on curing conditions, as cure advancement governs both the development of the polymer network and its response under thermo-mechanical loading. In this study, a bio-based epoxy system was investigated at both resin and composite levels in order to establish a consistent process–structure–property relationship.*
Differential Scanning Calorimetry (DSC) was performed on the neat bio resin as well as on the corresponding CFRP samples cured under four conditions, namely ambient temperature at 25°C (T25) and moderately elevated temperature at 40°C (T40), 50°C (T50) and 60°C (T60) using heated molds. First-heating and second-heating analyses were employed to capture residual curing effects, thermal history, and the stabilized behavior of the polymer network at both material scales.
The comparison between bio resin and composite responses highlights the influence of fiber reinforcement on the apparent thermal behavior, while also enabling the identification of cure-related descriptors representative of the material state. Heat Deflection Temperature (HDT), measured on the composites, was used as a macroscopic indicator of thermo-mechanical performance.
Building on this multi-scale dataset, a data-driven correlation approach is proposed, in which DSC-derived descriptors are used to estimate HDT. Within this framework, calorimetric parameters extracted from both resin and composite analyses serve as indicators of cure state, while HDT reflects the resulting structural performance. The results demonstrate the potential of integrating multi-level thermal characterization with predictive tools to support the optimization of bio-based composite systems for aerospace and other industrial applications.

Key Words: *bio-based epoxy, curing process, multi-scale analysis, data-driven approach, composites*



The effects of adherent geometry on the peeling behavior of adhesive tapes

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Abstract: *Adhesive bonding offers numerous advantages over traditional joining methods such as welding, riveting or mechanical fastening. It offers good fatigue resistance, thus contributing to a considerable reduction in maintenance costs over the product's lifetime. Another major benefit is the reduction in structural weight, which is essential especially in aerospace applications, where low wight is a critical factor.*
The present study evaluates the performance of three types of adhesive tapes, aluminum tape, Moment Power Tape and Kapton, in terms of adhesion to various surfaces, including painted and unpainted ones. The specimens on which the adhesive tapes were applied were made by additive manufacturing using resin, with variable geometry (rectangular, triangular and rounded edges), to evaluate the behavior of the tapes under different test conditions.
The 180° peel tests were initially performed at two test speeds, 5 mm/s and 15 mm/s, to observe the effects on the maximum adhesion force. The results indicate that the shape of the specimen edge slightly influences the measured values, but not in a consistent or significant way. Although specimens with triangular edges generally showed the highest adhesion performance and those with rounded edges had the lowest, these differences are not significant enough to conclude that the edge geometry has a decisive impact on adhesion, meaning that adhesive tapes are an useful solution regardless of the geometry and surface treatment.

Assessment of Static Divergence and Flutter Characteristics for a Fin Configuration

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Abstract: *Aeroelastic phenomena such as static divergence and flutter play a critical role in the structural integrity and operational envelope of lifting surfaces and control fins. These instabilities arise from the interaction between aerodynamic forces and structural flexibility, and must be carefully evaluated during the design process to ensure safe and efficient performance.*

This work presents a practical methodology for estimating the divergence speed (VD) and flutter speed (VF) of a representative fin geometry. The approach combines structural information obtained from finite element analysis with a reduced-order aeroelastic formulation based on generalized coordinates. Key parameters such as the elastic axis location, torsional stiffness, and aerodynamic characteristics are incorporated to capture the essential physics governing aeroelastic stability.

The methodology is first verified through simplified test cases and subsequently applied to a generic fin configuration. The results highlight the influence of structural and aerodynamic parameters on the onset of divergence and flutter, providing insight into the stability behavior of the system.

The proposed framework offers a computationally efficient and physically consistent tool for preliminary aeroelastic assessment, suitable for integration into early-stage design and analysis workflows.

Key Words: *Aeroelasticity; Static divergence; Flutter; Fin configuration; Reduced-order modeling; Elastic axis; Finite element method (FEM); Lift-curve slope; Aeroelastic stability; Eigenvalue analysis*

Modeling of Airfoil Ice Accretion Based on Aerodynamic Flow Fields and Droplet Collection

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Abstract: *This paper presents a low-fidelity computational framework for airfoil ice accretion prediction based on a coupled aerodynamic and droplet impingement model. The aerodynamic flow field around the airfoil is computed using the Hess–Smith panel method, providing an efficient inviscid approximation of the velocity distribution. The icing process is modeled through a Lagrangian droplet tracking approach, where individual supercooled water droplets are released upstream and convected under the influence of local flow velocities and drag forces. A key feature of the proposed methodology is the evaluation of the local collection efficiency using an incidence-based formulation, where the accreted mass depends on the normal component of the droplet impact velocity. This allows a more realistic representation of partial accretion and freezing phenomena on the airfoil surface. The ice growth is simulated iteratively by updating the airfoil geometry through a panel-wise thickness increment proportional to the liquid water content, freestream velocity, and computed collection efficiency. The numerical implementation enables time-dependent ice shape evolution, with periodic updates of the aerodynamic solution to account for geometry modifications. The method remains computationally inexpensive, making it suitable for parametric studies and preliminary design applications. Results demonstrate the capability of the approach to capture leading-edge ice accretion patterns and their progressive impact on airfoil geometry. The developed framework provides a robust low-fidelity alternative to high-cost CFD-based icing simulations, with potential applications in early-stage aerodynamic analysis and icing risk assessment.*

Key Words: *airfoil icing, low-fidelity models, Hess–Smith panel method, droplet tracking, collection efficiency, ice accretion*

Geometric Optimization of a Slotted Flap Configuration for Maximum Lift Enhancement

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Abstract: *Modern civil aircraft wings are designed primarily for cruise efficiency, but high-lift devices become essential during take-off and landing, where increasing the maximum lift coefficient and managing stall characteristics are critical. In multi-element slotted flap configurations, the aerodynamic characteristics is strongly governed by the flap channel, defined as the region between the trailing edge of the main airfoil and the leading edge of the deployed flap. This study investigates how geometric variations within the flap channel influence overall aerodynamic characteristics. A parametrization framework was developed using cubic Bézier curves to model flap geometries, ensuring that the retracted configuration remains unchanged while allowing smooth, continuous shape modifications during deployment. The inner channel geometry was further parametrized using local curvature distributions. To enable efficient exploration of this design space, a fully automated MATLAB workflow was developed, integrating geometry generation, mesh creation, and CFD simulations. This workflow was coupled with a gradient-based optimization loop targeting the maximization of the maximum lift coefficient, while simultaneously enforcing smooth post-stall behavior and delaying flow separation. Through iterative refinement of both the flap and channel geometries, the optimization process exhibited substantial lift improvements over the baseline configuration.*

Key Words: *slotted flap, parametrization, optimization, CFD, automated framework*

Mathematical modelling of helicopter flight performance

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Abstract: *The precise computation of helicopter flight performances is important for the initial design studies and the safety of the helicopter operations, during take-off or landing phases. This paper investigates the evaluation of essential performance parameters, including required and available power, rate of climb or acceleration, while incorporating the influence of environmental conditions such as air density and altitude. The algorithm provides useful insight and overall helicopter performance. The estimation of performance characteristics was illustrated in a MATLAB program for a helicopter in hover and forward flight. The ground effect was considered to avoid the overestimation of required power in hover or the misprediction of take-off performance. The induced velocity decreases with the ground proximity. In case of power loss, helicopters can land in autorotation regime. The consideration of ground effect and autorotation complete the evaluation of the helicopter flight performance. The results demonstrate that clear determination of the helicopter flight performance parameters can offer a practical balance between accuracy and computational efficiency. These insights contribute to improved rotorcraft design, optimization of flight envelopes, and enhanced mission planning.*

Key Words: *flight performance, helicopter, hover, translational flight, ground effect coefficient*

Aerodynamic and Flight Performance Analysis of an Electrically Converted Light Helicopter: Clean and Podded Configurations

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Abstract: *This paper presents an aerodynamic and flight performance assessment of a light helicopter converted to electric propulsion, with emphasis on the influence of external battery integration on overall aerodynamic efficiency and climb capability. The study is performed on the Mosquito XE light helicopter platform and compares two main configurations: an initial configuration with externally mounted battery pods and a modified podded configuration incorporating aerodynamic fairings for drag reduction. A combined low- and medium-fidelity numerical methodology is employed. Rotor performance is evaluated using Blade Element Momentum Theory (BEMT), actuator disk theory, and panel-based aerodynamic modeling, while the global flow field around the helicopter is investigated through Computational Fluid Dynamics (CFD) simulations performed in ANSYS Fluent. The rotor system is modeled using actuator disk approaches for both the main rotor and tail rotor. Simulations are conducted for hover and forward-flight conditions at inlet velocities ranging from 1 to 30 m/s. The numerical investigation includes analyses of pressure distribution, velocity fields, streamline topology, boundary-layer separation, induced vortical structures, drag forces, power requirements, and climb performance. The results indicate that the aerodynamic integration of the battery system has a significant influence on helicopter performance. The initial externally mounted battery configuration generates extended separation regions and increased aerodynamic drag, particularly at higher forward-flight velocities. The modified faired configuration substantially reduces wake recirculation and flow separation, leading to drag reductions of up to approximately 50% at 30 m/s. Performance calculations further show improvements in vertical climb speed and required power characteristics for the optimized geometry. The study also highlights the influence of altitude and air density on climb capability and rotor power demand. In addition, the paper discusses preliminary thermal and safety considerations associated with Li-ion battery integration in electrically powered rotorcraft, including numerical investigations of thermal propagation and combustion phenomena for 21700-type battery cells. The presented results demonstrate the feasibility of electrically converting a light helicopter platform and emphasize the importance of aerodynamic integration of battery systems in improving flight performance and operational efficiency.*

Key Words: *light helicopter, electric power, podded accumulator, CFD, flight performance, actuating disk*

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Optimization of the photovoltaic and wind turbine electrical power distribution and storage

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Abstract: *Due to the fact that the photovoltaic and wind turbine production power level is most of the time variable and unpredictable, it is necessary to optimize its distribution between consumers and storage systems. This balance needs to be controlled by an algorithm for optimum use of this energy to reach maximum efficiency. The needs to adapt fast on both short and long term variations of production and demands of power and energy levels is resolved by combining the existing classical power distribution control systems with new and modern algorithms for the best optimization of the system. This algorithm will split not only the solar and wind electrical power produced between consumers and storage systems, it will also do this for the stored energy when the production level is lower than power demands.*
The structure is a modular type and consists of multiple local power management systems connected to a general master control system. For assuring a safe and smooth operation, this system is provided with additional error monitoring and health monitoring systems. The error monitoring system decides when local and general power management systems become unreliable and will switch automatically to the classical power distribution operating mode. It also will analyze what exactly has caused the abnormal operation and will try to correct the errors and eventually reactivate that system in the case of successful operation.
The health monitoring system is structured on multiple levels. The basic level of this system is continuously monitoring and storing the main working parameters such as voltages, electrical currents and temperature values for the components and also the environmental parameters for detecting abnormal working conditions. On the next level, all the main devices and components are periodically tested for a short time to check if they can work properly on the maximum operating conditions. The highest level of the health monitoring system is analyzing the previously stored data to verify the behavior of the local and general power management system.

Key Words: *solar and wind turbine power distribution, optimization of electrical power distribution, health monitoring system*

Computer Vision Based Guidance, Navigation and Control for Autonomous Aerial Vehicles: A Systematic Survey

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Abstract: *This systematic survey examines advances in computer vision techniques that support guidance, navigation and control (GNC) for autonomous aerial vehicles (AAVs) - including multirotor UAVs, hybrid VTOL/eVTOL platforms and fixed wing drones - operating in unstructured, GNSS-denied environments. Guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, a targeted query was used to perform a literature search across six academic databases for the period 2005–2025. Each selected contribution was mapped onto the five functional stages of autonomous flight operations - sensing, perception, navigation, guidance and control - producing a comprehensive comparison matrix that links computer vision algorithms, sensor configurations and vehicle classes. The synthesis shows that current aerial vehicle autonomy relies mainly on visual inertial odometry (VIO) and visual SLAM (vSLAM) pipelines. Among the simultaneous localization and mapping (SLAM) solutions, ORB-SLAM3 stands out for multi-map capability and support for monocular, stereo and RGB-D inputs, making it a robust backbone for GNSS-denied localization. For real-time obstacle detection, one stage deep learning detectors such as YOLO-v8 and YOLO-Tiny achieve frame rates exceeding 30 FPS on embedded GPUs, while two stage architectures (R-CNN, Faster R-CNN) provide higher detection accuracy at the expense of latency. Adaptive multimodal sensor fusion - combining cameras with inertial measurement unit (IMU), light detection and ranging (LiDAR), radar or event-based sensors - substantially mitigates the impact of adverse illumination, weather and texture-poor scenes, thereby extending operational envelopes. However, three main gaps limit the transition from prototypes to certifiable flight systems: limited robustness in extreme conditions, the need to integrate perception with flight control hardware efficiently, and the lack of standard benchmarks and certification for AI perception. The paper calls for full-cycle datasets, research on low-power inference and hardware acceleration, and regulatory paths that include explainable AI and continuous monitoring. Overall, this study provides an exhaustive classification and performance comparison of computer vision solutions for autonomous aerial vehicles, clarifies the strengths and limitations of existing approaches across vehicle categories.*

Key Words: *Computer vision, Visual guidance, Visual navigation, AAV/UAV/eVTOL, Visual SLAM, Computer vision algorithms*

Space Rider Drop Test (SRDT)- DLTM and MGSE DESIGN, MANUFACTURING and TESTING

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Abstract: *This paper presents INCAS contribution to the development of ESA Space Rider Drop and Landing Test Model (DLTM) and associated MGSE equipment.*
Space Rider (Space Reusable Integrated Demonstrator for Europe Return) is a reusable, uncrewed European space laboratory developed by the European Space Agency (ESA) for scientific research in Low Earth Orbit (LEO). The vehicle is approximately 5 meters long, weights around 3 tones, and can carry up to 600 kg of payload. It is designed to support a wide range of experiments in microgravity, contributing to research in areas such as biomedicine, pharmaceuticals, biology, and physical sciences. After launch aboard a Vega-C rocket, Space Rider will operate in orbit for about two months before returning to Earth through a controlled re-entry and landing using a paraglider system. Its design allows it to be recovered, refurbished, and reused, following the Return, Reload, Relaunch concept, making it a key element of Europe's sustainable approach to space missions.
Within this program, INCAS has played a crucial role in the development, manufacturing and testing of the Space Rider Descent and Landing Test Model (DLTM), a full-scale experimental prototype with a Technology Readiness Level (TRL) of 5–6. This demonstrator replicates the real spacecraft in terms of geometry, mass distribution, and functional systems, including the autopilot, avionics, parachute system (three parachutes), and a skid-type main landing gear system.
The model is designed specifically to test the complete descent and landing sequence under realistic conditions. To ensure the Assembly Integration & Test/ Assembly Verification & Test (AIT/AIV) activities as long as the transportation and the interface with the carrier, dedicated Mechanical Ground Support Equipment (MGSE) (AIT/AIV trolley, transportation cradle and beam) are designed in order to ensure the achievement of the objectives of the DLTM vehicle. The demonstrator and all Mechanical Ground Support Equipment (MGSE), were manufactured and assembled at–INCAS Technology for Green Aviation Center in Craiova.
The DLTM will be used in the final functional test campaign, which includes drop tests conducted at the Salto di Quirra test range in Sardinia in Q2 of 2026. These tests involve releasing the demonstrator from a CH-47 Chinook helicopter from an altitude of approximately 3,000 meters. The purpose is to validate autonomous descent, flight stability, and precision landing capabilities under realistic operational conditions. The landing system must achieve high accuracy, targeting a 300-meter diameter landing zone, guided entirely by an autopilot and an autonomous controlled parachute system.
Overall, INCAS's contribution spans the full development cycle of the DLTM, from early aerodynamic testing and full-scale design to manufacturing, structural validation, and preparation for flight testing.
The institute's work ensures that the demonstrator accurately replicates the behaviour of the actual Space Rider vehicle during re-entry and landing, making it a key step in validating Europe's reusable space transportation system and its autonomous landing technologies.

Key Words: *full scale demonstrator, design, manufacturing, ground testing, autonomous flight, descent and landing, drop test.*

Design of a high-pressure test bench for air jets simulation experiments for crew escape system thrusters

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Abstract: *Space exploration is currently undergoing sustained development, with commited steps being taken towards crewed missions. The crew escape system is an essential component of a space vehicle and is designed to ensure the safe return of the crew during the launch and ascending phase in the event of a launch abort. Test campaigns that simulate the operation of escape system thrusters using high-speed air jets represent an essential step in the development and validation of such systems.*

This paper presents the design and implementation of a high-pressure test bench capable of generating supersonic air jets for thruster simulation. The facility is intended to reproduce relevant flow conditions associated with escape system operation in the context of scaled model testing in a wind tunnel, enabling the experimental investigation of aerodynamic loads, flow interactions, and system response. Particular attention is given to pressure regulation, flow/pressure control, and measurement accuracy, ensuring reliable and repeatable test conditions. The instrumentation and the data acquisition system of this test bench is designed to ensure a reliable body of data suitable for the tests's specifications. The developed setup provides a versatile platform for supporting the experimental validation of crew escape system components under representative operating scenarios, and at the same time this test bench represents a reliable tool for conducting similar tests involving the simulation of jet effects generated by crew escape system thrusters, as well as for other related applications.

Key Words: *high-pressure test bench, thruster simulation, supersonic jets, crew escape system, active launch escape/abort system*

XCAS – Conflict Awareness System for Ground and Airborne Operations

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Abstract: *This paper presents the concept, design, and implementation of an extended Conflict Awareness System (XCAS), as a pilot-centric solution developed to enhance situational awareness and decision support across both airborne and ground operations. XCAS system will increase safety for specific operations in congested airport environments and may be used as an assistance tool in the cockpit.*

Our development for the proposed system is based on real-time data extraction from a simulated environment (ASAS system existing at INCAS) using Lockheed Martin Prepar3D software packages and the SimConnect SDK tools. The main target is related to INCAS implementation for two representative scenarios: a Boeing 737-800NG and an Airbus A320 operating at Henri Coandă International Airport (LROP/OTP) in real traffic conditions.

XCAS extends classical Collision Avoidance System (CAS) paradigms beyond conventional implementations such as TCAS and broader ACAS concepts, by shifting from purely passive/informative awareness, to pro-active enhanced pilot-driven situational awareness within the Air Traffic Management (ATM) context. The system directly supports the pilot during operational phases, including takeoff, landing, and taxi, without relying on external Air Traffic Control (ATC) inputs.

In the airborne module (XCAS-Air) integrates and visualizes surrounding traffic data—such as position, speed, altitude, and heading—allowing the pilot to assess relative proximity and potential conflicts through a lightweight, real-time processing model. In the ground module (XCAS-Ground), the system introduces a structured airport surface navigation framework based on predefined waypoints and standard taxi routes, enabling conflict detection at intersections, during pushback operations, and along converging taxi paths. Globally, everything is integrated in a safety bubble conceptual approach, able to meet safety requirements for this type of operations.

A dual-objective approach is implemented, combining safety (conflict detection and avoidance) with operational efficiency (optimized taxi routing within allocated time constraints). The system supports three key pilot-centric operational phases: (1) initial aircraft acquisition and surface situation assessment, (2) decision support for pushback and taxi/landing clearance, and (3) autonomous ground route reconfiguration based on safety-driven criteria and ground traffic congestion.

The core contribution of this work lies in conceptual development for XCAS and specific demonstrations in a relevant environment at high TRL level, exploiting simulation data from ASAS system as a dynamic environment. Furthermore, the XCAS concept establishes a foundation for future developments toward predictive conflict detection, including trajectory-based operations (TBO), 4D trajectory modelling, enabling anticipation of potential conflicts rather than passive/reactive avoidance.

Key Words: *XCAS, ATM, B737-800NG, A320, ground operations, taxi optimization, SimConnect, conflict awareness, airport surface, TBO*

Real-Time Conflict Detection and Intercept Planning for ATC Simulation

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Abstract: *This paper presents a lightweight controller support tool developed for situational awareness in simulation-based air traffic control research. The system connects remotely to a Prepar3D v4 flight simulator via SimConnect LAN and streams real-time aircraft state data including position, velocity, and heading. Two core predictive algorithms are implemented. Conflict detection is based on the exact vector Closest Point of Approach (CPA) formula [1] , which provides geometrically precise separation estimation without the scalar approximation used in TCAS. Intercept planning employs an iterative fixed-point algorithm converging to the Predicted Intercept Point (PIP) [2], which computes the recommended heading for the intercepting aircraft at each update cycle. Two operational scenarios are presented. The first demonstrates drone interception against a maneuvering UAV, in which the PIP is recalculated continuously as the drone changes heading, illustrating algorithm robustness under unstable target dynamics. The second demonstrates an air-to-air refueling rendezvous against a constant-heading tanker, producing a stable PIP and an automatically generated ATC clearance including heading, altitude change, and estimated time to contact. The proposed approach demonstrates the applicability of well-established predictive algorithms to simulation-based airspace scenarios, offering a potential foundation for further investigation in controller decision support.*

Key Words: *air traffic control, situational awareness, conflict detection, closest point of approach, predicted intercept point, drone interception, air-to-air refueling.*

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[2] E. J. Song, M. J. Tahk, *Real-time midcourse guidance with intercept point prediction*. Control Engineering Practice, 6(8), 957-967.

Gust Alleviation Control with delay – a study case

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Abstract: *This paper presents a short-period longitudinal flight dynamics model incorporating a gust alleviation controller with time delay. The study focuses on the impact of delayed control actions on system stability and dynamic response. A mathematical model is developed based on a two-state representation (angle of attack and pitch rate), including gust-induced angle of attack and control surface dynamics (flap and elevator). The controller structure introduces both proportional and delayed feedback, leading to a system described by delay differential equations. The stability analysis is performed using the Laplace transform, resulting in a characteristic quasi-polynomial. The influence of delay on system stability is investigated through analytical conditions and critical delay computation. A parametric study is conducted considering variations in flight velocity, center of gravity position, and gust intensity. Results highlight the sensitivity of stability margins to time delay and demonstrate the importance of appropriate controller tuning in gust alleviation systems.*

Development and Validation of a Portable Ground Control Station for UAV Applications

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Abstract: *This presentation focuses on the development of Ground Control Station (GCS) systems designed to support UAV-based missions, highlighting the transition from concept to operational solutions within a technology development and Technology Readiness Level (TRL) framework. The work is motivated by the growing need for reliable command and control systems in UAV applications such as monitoring, inspection and surveillance, where operator interaction, data visualization and mission management are critical. While UAV platforms represent the aerial component of the system, the effectiveness of the overall solution is strongly dependent on the capabilities and design of the Ground Control Station. The presentation first introduces a vehicle-integrated GCS, developed to support mobile UAV operations. This solution provides high processing capability, multiple operator workstations and integrated communication systems, enabling real-time control of both the UAV and its payload. Special attention is given to system integration aspects, including ergonomics, equipment layout and accessibility. Based on operational experience and field testing, several limitations of the vehicle-based approach were identified, particularly regarding deployment flexibility and logistical constraints. These findings led to the development of a portable Ground Control Station, designed as a compact, self-contained system capable of supporting UAV missions without the need for a vehicle platform. The article outlines the key design requirements for the portable GCS, including portability, power autonomy, processing capability and interface integration. It also emphasizes the importance of iterative development, system validation and testing in real operational environments.*

Future work focuses on advancing the system towards higher TRL levels through testing in harsh environmental conditions, extended field validation and improvements in robustness and reliability. The presented work illustrates how Ground Control Stations evolve as critical components in UAV ecosystems, bridging the gap between technology prototypes and operational systems.

Key Words: *Unmanned Aerial Vehicle, Ground Control Station, command and control, field testing, Technology Readiness Level, system integration, portable, operator interface*

Digital Avionics Display for ArduPilot

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Abstract: *This paper presents the development of a software application engineered to display the state of an aircraft on digital monitors in real time, allowing the pilot to properly maneuver it. It was developed using the Qt framework for C++, taking advantage of the powerful producer-consumer architecture offered by Qt. The application acts as a TCP or UDP client, depending on the desired setup, receiving data from an ArduPilot device, which is connected to the same network, or directly wired to the host computer with an Ethernet cable, allowing for high speed communication between the devices. Data is parsed using MAVLink 2.0 headers generated with the official MAVLink header generation Python application, and the ardupilotmega XML file, ensuring complete compatibility between ArduPilot and the software module. To achieve fluid motion and animation in the QML components, the application uses a multithreading strategy, where a secondary thread running in the background is responsible for reading and parsing the data, while the main thread renders the graphical components. The received data is stored in shared memory, and is made thread safe by using the Qt multithreading functionality. By using Qt, the code can be compiled for both Windows and Linux environments, making the application extremely portable.*

Key Words: *Avionics, MAVlink, ArduPilot, TCP, UDP, Qt*

Design of an Electromechanical Actuation System for Optional Autopilot Integration on a Ultralight Aircraft

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Abstract: *This paper presents the design of an electromechanical actuator system developed to enable autonomous flight control of an ultralight aircraft. The system allows the aircraft to fly autonomously when the pilot releases the controls, while preserving full manual authority at all times. Actuators are installed on all three primary control surfaces — aileron, elevator, and rudder. The core design concept is an overlaid architecture, where the actuator is added to the existing mechanical command chain without replacing it. In manual mode, the pilot operates the controls normally with no added resistance. When the autopilot is activated, a solenoid engages a mechanical coupling that transfers control of the surface to a brushless motor. If power is lost at any point, a return spring automatically disengages the coupling, giving the pilot back full control without any action required. Motor control uses Field-Oriented Control with an absolute position encoder, providing smooth and precise surface movement at the low speeds required for flight control.*

Key Words: *electromechanical actuator, flight control, optionally piloted vehicle, ultralight aircraft, field-oriented control, electromagnetic coupling, fail-safe, TRL 4*

Development of a General-Purpose Flight Controller

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Abstract: *This paper presents the first development stage of a general purpose flight controller intended for use across multiple autonomous aerial platforms, including multicopters, fixed-wing aircraft, vertical take-off and landing systems, and thrust vector controlled rockets. The work is based on the development of the Navis Flight Controller, a modular embedded platform designed for real-time data acquisition, onboard processing, actuator command generation, and experimental validation of control algorithms. The first version of the controller focuses on validating the hardware architecture, sensor integration, communication interfaces, and basic control capability required for stable flight. The system was designed as a flexible research and development platform, allowing future adaptation to different vehicle dynamics through software configuration and modular hardware expansion. This first version has already been successfully tested on a quadcopter, demonstrating its capability to operate as a multicopter flight-control unit. At the same time, the controller is currently being integrated and tested on an electric thrust vector control demonstrator, representing an important step toward its future use in rocket attitude-control applications. Through these validation stages, the project aims to establish the foundation for a deployable, general purpose flight controller capable of supporting a wide range of aerial vehicles within a unified architecture.*

Key Words: *flight controller, autonomous aerial vehicles, multicopter, fixed-wing aircraft, vertical take-off and landing, thrust vector control, embedded systems, control algorithms.*

Recent Developments in Aerodynamic Damping Test Rigs at the INCAS Trisonic Wind Tunnel

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Abstract: *The INCAS trisonic wind tunnel has developed a set of specialized rigs for the experimental determination of aerodynamic damping coefficients, supporting dynamic stability investigations across a wide range of flow regimes. Currently, the facility operates a roll damping rig capable of both free and forced rotation testing, enabling comprehensive characterization of roll damping behavior. A pitch damping rig based on the free oscillation method is also in use, with ongoing efforts focused on upgrading the system to incorporate forced oscillation capabilities for improved accuracy and control.*

In addition, a free-to-tumble rig is employed to evaluate pitch and yaw damping coefficients through free oscillation measurements. Recognizing the limitations of purely free-motion approaches, current development activities aim to enhance this rig to expand its functionality and measurement fidelity.

This paper presents an overview of the existing experimental setups, recent upgrades, and ongoing developments, highlighting their role in advancing aerodynamic damping assessment techniques within the INCAS trisonic wind tunnel. The improvements are expected to provide more accurate and versatile testing capabilities, supporting both research and industrial applications in flight dynamics and stability analysis.

Key Words: *Wind tunnel, dynamic measurements, roll damping, pitch and yaw damping, free-to-tumble, experimental aerodynamics*

Uncertainty Propagation for Wind Tunnel Data Post-Processing: Application to a Test Model

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Abstract: *Reliable wind tunnel data reduction requires a clear quantification of the uncertainty associated with each derived flow parameter and aerodynamic coefficient. In practical post-processing workflows, primary measurements such as total pressure, static pressure, total temperature, model incidence angle, balance loads and pressure tap readings are successively transformed into quantities such as Mach number, static temperature, density, airspeed, dynamic pressure, Reynolds number, and aerodynamic coefficients. This paper presents a structured methodology for estimating standard uncertainties in wind tunnel data post-processing using the chain method, also known as the law of propagation of uncertainty. The approach is based on first-order sensitivity propagation, assuming independent input quantities, and is applied point-by-point to a reference wind tunnel test model. The practical case is used to demonstrate the uncertainty propagation workflow and to identify the dominant measurement sources that affect each output quantity, rather than to analyze the aerodynamic behavior of the model. The resulting framework provides a traceable procedure for integrating uncertainty estimation directly into wind tunnel data processing and can be used as a reference for similar experimental campaigns.*

Key Words: *Wind tunnel testing, uncertainty propagation, chain method, data post-processing, standard uncertainty, aerodynamic coefficients, flow parameters*

Selection of Critical Load Cases for Static Testing of a Rotorcraft Fuselage Upper Deck Specimen

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Abstract: *This paper presents state of the art procedures for determination of critical load cases of an aerial vehicle both for stress evaluation and for determining the load cases to be statically tested as required by certification specifications in effect for Type Certificate or Permit to Fly. A case study will examine the test load case selection process for a fast rotorcraft developed under an European research program, in which INCAS was responsible for design, stress analysis and testing in support of the Permit to Fly. As a preliminary activity, the regulatory certification requirements were established, along with the main structural elements whose strength had to be validated through testing. A standard approach for selecting critical cases will be outlined, involving the creation of force and moment diagrams at predefined fuselage or wing stations, followed by grouping load combinations at each station into separate plots and identifying the critical combined values. Given the complexity of the local structure and the configuration of the test specimen, a more direct approach based on FEM stress results was adopted. Stress values and their associated load cases were extracted at various hot spots for each PSE component, leading to the identification of several critical load cases per part. Critical interface loads, fastening elements, and their corresponding load cases were also taken into account. A set of critical load cases was established by filtering for common cases and validating them against those identified through static stress analysis and defined in the Loads Manual. The selected test cases were used to define the test setups, load magnitudes and directions, strain gauge and displacement sensors mapping and to validate the structure through static testing in support of the Permit to Fly.*

Key Words: *static testing, critical load cases, Permit to Fly, certification, Principal Structural Elements, interface loads*

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1st INCAS Spring Conference
"ISCO 2026"
07 MAY 2026 | BUCHAREST, ROMANIA

Publisher:

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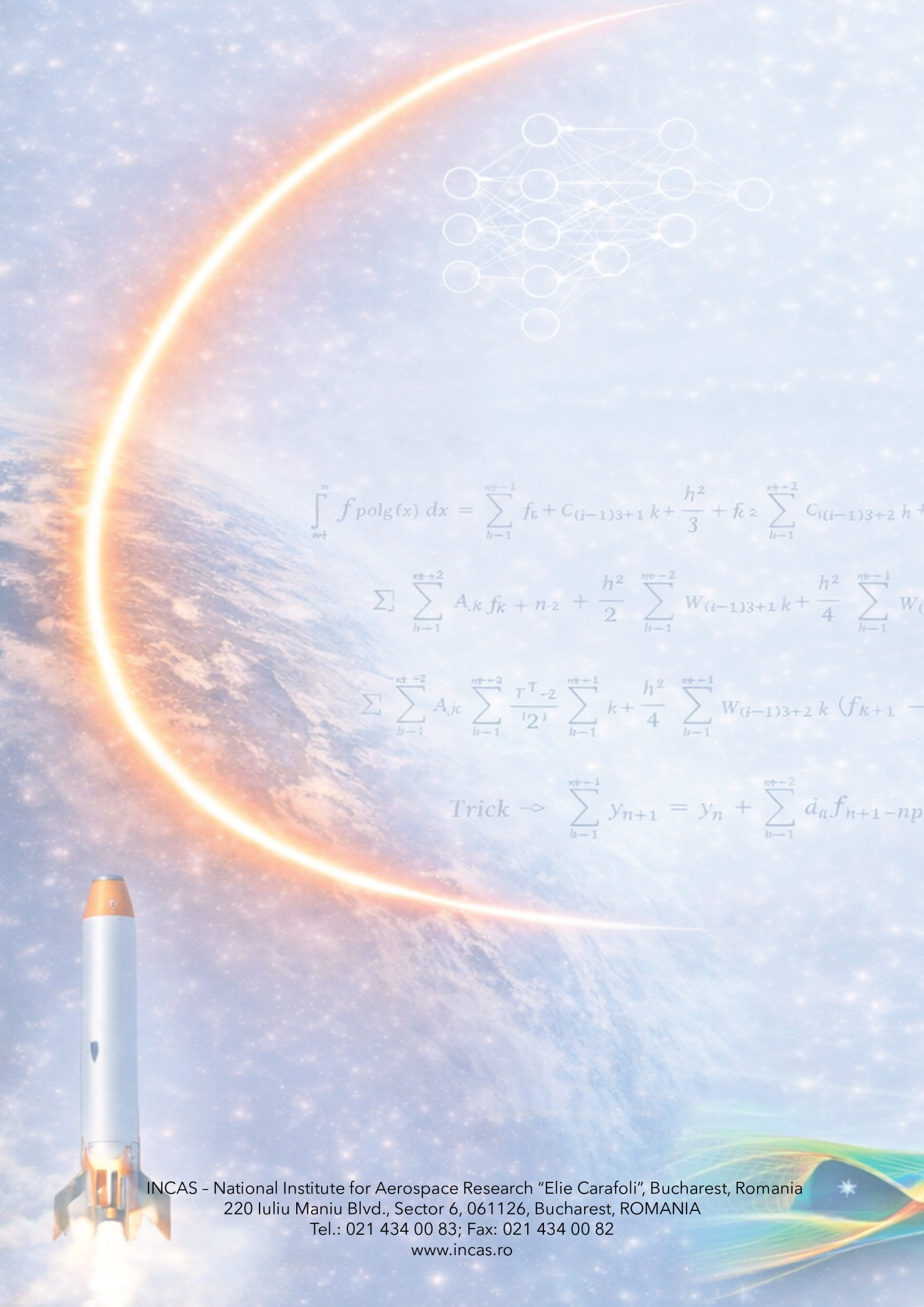

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