H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

Title of the research project: Enhanced unmanned aerial vehicle platform using integrated innovative layout configurations and propulsion technologies

Principal Investigator: Dr. Pericles Panagiotou

Reader-friendly title: Novel UAV platform optimization through the investigation and integration of aerospace technologies

Scientific Area: Aeronautical engineering

Institution and Country: Department of Mechanical Engineering, Faculty of Engineering, Aristotle University of Thessaloniki, Greece

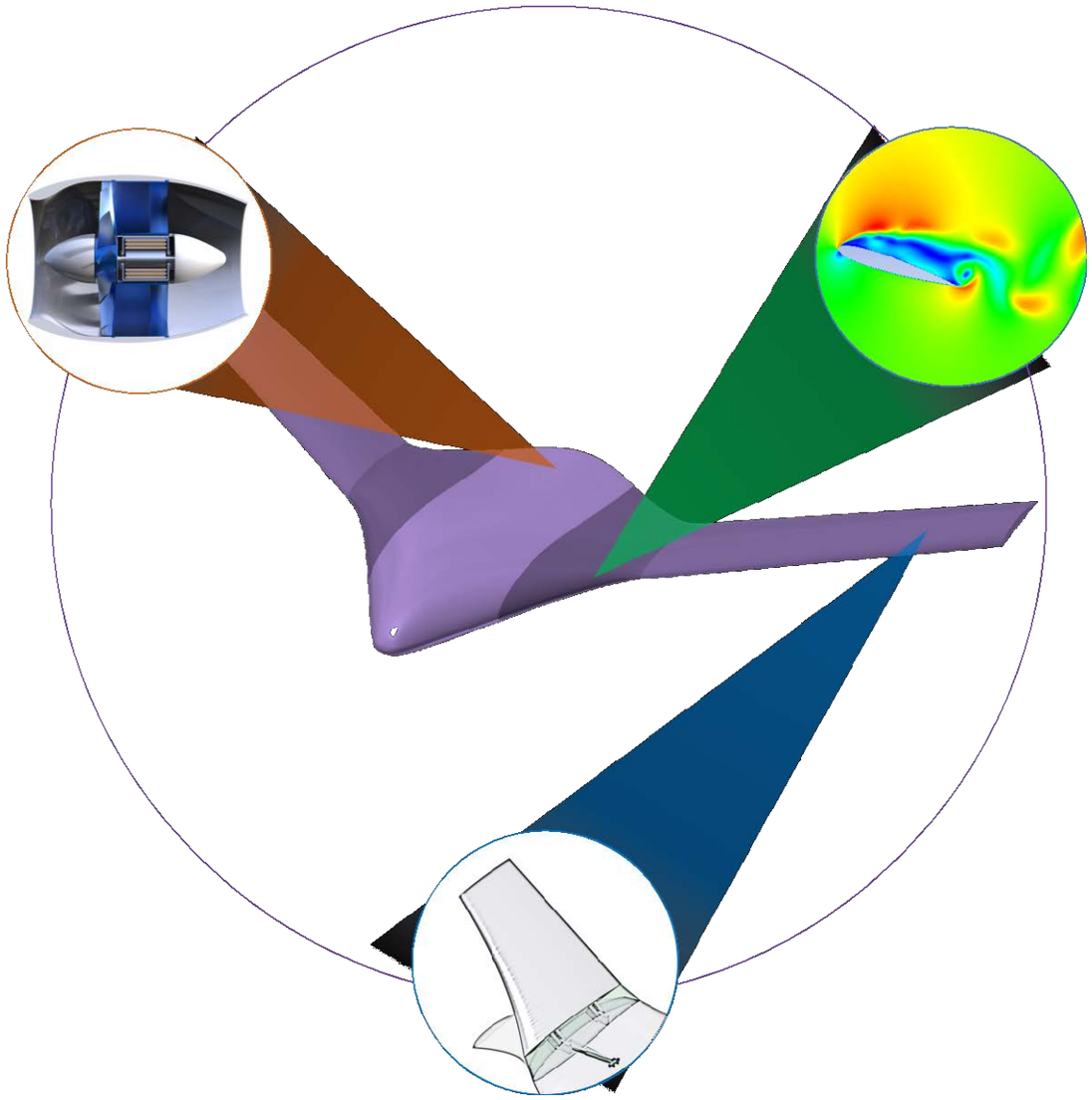
Host Institution: Department of Mechanical Engineering, Faculty of Engineering, Aristotle University of Thessaloniki, Greece

Collaborating Institution(s): -

Budget: €199,673.91

Project webpage (if applicable): -

Duration: 27 months



Research Project Synopsis

The main goal of the EURRICA project is the synergetic evaluation of disruptive technologies on a novel Blended-Wing-Body medium-sized, fixed-wing Unmanned Aerial Vehicle (UAV) platform. The BWB layout is selected as the base platform due to reasons related primarily to its great aerodynamic efficiency and large internal volume. The research activities will focus on three main categories, i.e. the supporting configuration layout (e.g. winglets, morphing configurations), the flow control (active and passive) and the hybrid-electric propulsion (parallel or serial) technologies. Since the majority of technologies have not been examined for UAV applications, the analysis will be kept at low Technology Readiness Level (TRL1-2). As a start, the reference requirements and design regulations will be set, followed by the base BWB UAV platform definition. A technology screening will then be conducted, and the various technologies will be individually investigated, emphasizing on their aerodynamic efficiency and performance enhancement potential. The optimal ones will be selected for integration and synergetic evaluation on the BWB UAV platform, where the technologies selection will be refined using trade factors. A scaled-down model will be manufactured and flight tested, to support the calculations for the final assessment. The plethora of technologies will initially be filtered using the information available in the literature and by employing rapid, low-fidelity 0D and 1D in-house analysis tools. High-fidelity computational tools will be incorporated to increase the results precision, but only as the project progresses and the number of considered technologies is reduced, to cut-down the time and resources for the EURRICA project. The scientific results of the EURRICA project will help to mature the examined technologies for UAV applications, leading to significantly more efficient and reliable aerial vehicles that can be used to protect human lives and infrastructure.

Project originality

In the 21st century the fixed-wing Unmanned Aerial Systems (UASs) market presents booming, multi-billion, figures. Recent advances in the fields of aeronautics and electronics have allowed the development of complex UASs, capable of carrying out a variety of missions. The effectiveness of those systems is largely based on their respective Unmanned Aerial Vehicle (UAV) platform and, more specifically, on its layout design characteristics and performance specifications. Optimizing the aerodynamic efficiency and enhancing the performance of a UAV is of outmost importance, since a more efficient configuration is more likely to have an advantage in the market, for example, in terms of flight time and payload capacity.

There are several studies that describe the design of UAVs, however little-to-no effort is made on optimizing their aerodynamic efficiency and performance and, even then, the analysis is relatively limited. The innovative technologies exploitation remains largely unaddressed in fixed-wing UAV-related research, thus limiting their potential.

In an attempt to address this gap, in the EURRICA project novel configuration layouts, flow control techniques and propulsion architectures are considered for evaluation in terms of aerodynamic efficiency and performance enhancement potential for fixed-wing UAVs. The reference platform is based on the innovative Blended-Wing-Body (BWB) layout, as it is arguably one of the most promising alternatives to the conventional, tube-and-wing, configuration layout, offering a 30% increase in terms of aerodynamic efficiency (Lift-to-drag, L/D) and a corresponding enhancement in terms of performance and fuel burn. Its unique streamlined shape also leads in a considerable increase in internal volume, which means that various payload components can be installed, not to mention the potential for larger fuel tanks or Hybrid-Electric Propulsion Systems (HEPS). The results of the EURRICA research project are expected to have a considerable impact on fixed-wing UAVs optimization approach, by providing previously unavailable tools and methods.

Expected results & Research Project Impact

The scientific ambition of the EURRICA project is to exploit the advantages of the disruptive layout technologies, Flow Control Technologies (FCTs) and Hybrid Electric Propulsion Systems (HEPS) in terms of aerodynamic efficiency and performance enhancement, to investigate their integration potential on a Blended-Wing-Body (BWB) UAV platform, and to share these findings with the scientific community and the aeronautical industry. Initial data indicate that a considerable, even double-digit, enhancement is expected in terms of aerodynamic efficiency and fuel consumption, which also reflects on the performance specifications. Regarding their synergetic operation though, there are no existing data for UAV applications, leaving this conclusion to be extracted based on the EURRICA research activities. What is more, the project findings can be extrapolated to the commercial airliner research community, by providing a comprehensive analysis of the synergies and interaction between the various technologies.

As far as technology readiness is concerned, many of the technologies are already in TRLs 4 to 8 individually, as far as commercial airliner applications are concerned. However, the TRL for UAV applications is still at a low level, especially if one is to investigate their synergetic operation. Through the EURRICA research activities, the TRL will be elevated from TRL1 to TRL2 for UAV applications, both on an individual and integrated level, and TRL4 for the scaled-down flight demonstrator.

Concerning the social impact, UAVs have the ability to operate in hazardous environments and support, or potentially entirely replace, personnel that operate on the “front line” (fire fighters, rescuers, volcano inspectors etc.), keeping humans from harm’s way and allowing them to perform their missions more efficiently. Research on disruptive technologies for UAV applications can lead to significantly more efficient and reliable aerial vehicles, which operate for the protection of human life and valuable infrastructure.

The importance of this funding

Receiving the H.F.R.I. funding as a Postdoctoral Researcher in the field of aeronautics is a great honor and opportunity, not only to me as a PI, but to a group of young and talented engineers, as a whole. The funding allows us to conduct high-quality research that combines cutting-edge topics, such as UAVs, novel layouts (due to its challenging design, very few examples of BWB aircraft exist, most notably limited to NASA and Airbus demonstrators) and disruptive aeronautical technologies.

Aeronautics is arguably one of the most challenging and visionary fields of engineering and most advanced nations and economies worldwide invest heavily (and are proud of their advances) in aviation. Funding opportunities like this one are a unique chance for us to continue working on the field and, at the same time, to keep the results of our research and the corresponding know-how within the borders of our country.

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