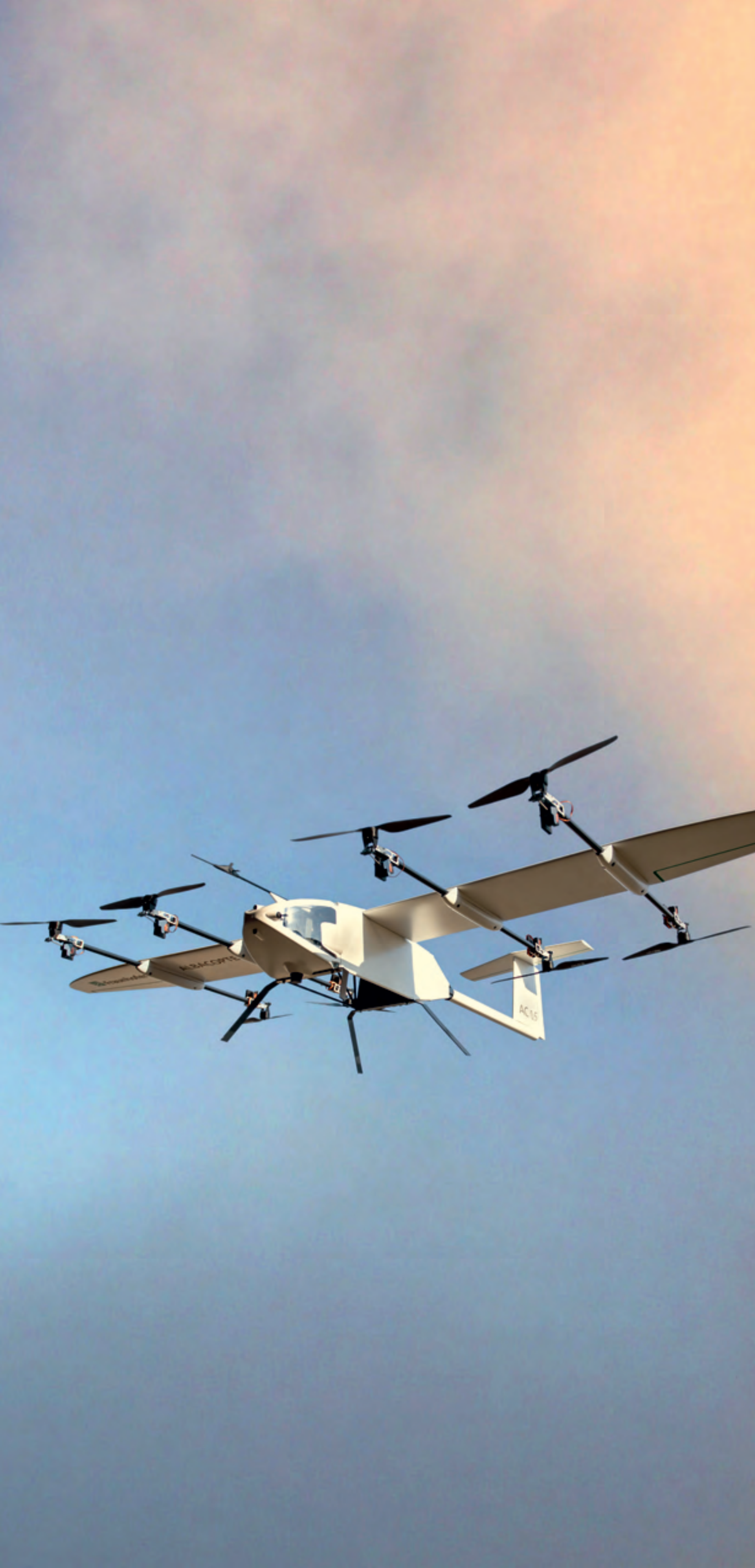
Fraunhofer ALBACOPTER® Flagship Project

Experimental Vertical Take-Off and Landing Glider

www.albacopter.fraunhofer.de/en


AC 1.5

Shifting parts of urban traffic into the air is no longer a dream of the future. Within the Fraunhofer ALBACOPTER® Flagship Project, a flying experimental platform with the vertical take-off and landing capability of a multicopter and the aerodynamic advantages of a glider is to be developed and approved for test and demonstration flights.

The goal within the project led by Fraunhofer IVI is to realize several variants and expansion stages of platforms for demonstrating the individual technologies. Thus, in a first step, the all-electric ALBACOPTER® 0.5 with a maximum take-off weight (MTOW) of 125 kg is being developed.

Six Fraunhofer Institutes (IVI, LBF, ICT, IOSB, IEM, IMS) are contributing their expertise and technologies from the fields of mobility, materials science, energy and drive technology, mechatronics, microelectronics, sensors, communication, automation and production technology, and artificial intelligence (AI) to this ambitious research project.

Vision of the Fraunhofer ALBACOPTER® Flagship Project

The Fraunhofer-Gesellschaft is addressing the current challenges facing German industry with its flagship projects. ALBACOPTER® sets strategic priorities to develop concrete solutions for Urban/ Advanced Air Mobility in Germany. The research questions pursued are geared to the practical requirements of this dynamic and demanding domain, with the aim of rapidly transforming scientifically excellent ideas into marketable products. The Fraunhofer institutes involved pool their expertise and involve industrial partners at an early stage in order to develop an overall system of this magnitude including associated key technologies in a targeted manner in line with market requirements.

Aerodynamic structures

The core content of the subproject includes the design, construction and manufacturing of structural ALBACOPTER® components with the aim of prototyping a lightweight, sustainable and aerodynamically favorable aircraft. The method development for the structure's design is mission-oriented, taking into account the associated requirements of the different flight phases for, e. g., aerodynamics and strength as well as multiple boundary conditions from the design and manufacturing processes.

The fuselage is laid out and designed for the integration/ adaptation of the various system components. These include, for example, battery and electronics as well as emergency rescue and sensor systems. The central fuselage - assembled in a skeletal design - includes nodes, support plates and struts, the latter being presented as innovative pultruded CFRP hollow sections (tubes) with thermoplastic matrix. A novel combined thermoforming and winding process joins the tubes to connectors with high strength, creating modular semi-finished products for the fuselage structure. Nose and tail sections with fuselage connection, tailplane and rudder, as well as the wing with adaptation options for fuselage and engine mount are designed in fiber composite shell construction, partly as a sandwich structure.

The sustainable, scalable lightweight transport case is made of self-reinforced thermoplastics. The fibers, matrix and foam core of the sandwich modules consist of the same material, which enables single-variety recycling after the use phase.

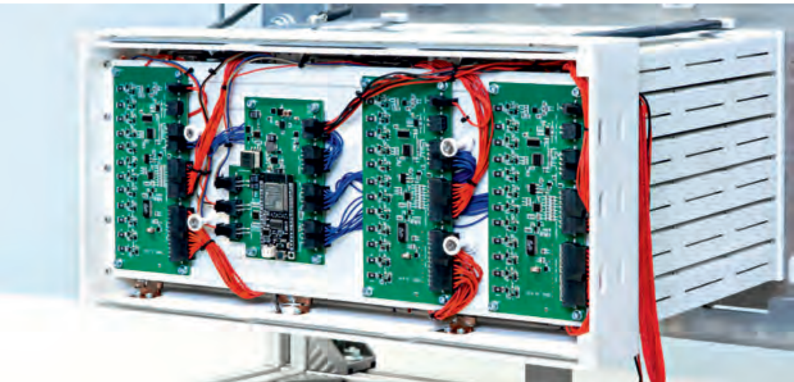
Drives and energy storage units

The experimental platform's propulsion system is composed of an energy storage system with optional shore power supply and powerful modular drives.

The energy storage system provides the electrical energy required for flight missions in a weight-optimized, reliable and safe manner. It combines high-energy and high-current capabilities to cover the high power requirements during takeoff, charging and hovering, as well as the energy requirements for level flight.

High-speed drives with gear reduction are used for maximum efficiency with high gravimetric power density and robustness. For the early validation of these systems, a test rig was developed that allows realistic testing of drive systems up to 350 kW.

A special feature of the ALBACOPTER® concept is that the aircraft is supplied with power via a cable during vertical take-off from an e-hover system, in order to be able to use freed-up battery capacity for longer flight missions. Solutions are provided for electrical and mechanical control in different weather conditions as well as for ejection of the plug system.



Autonomous flight

Autonomous aircraft require attitude control, avionics components, a ground control station, and AI-based algorithms to perceive their environment and respond to a wide variety of flight situations. The control algorithms developed linearize the coupled nonlinear dynamics of flight devices. For validation, both software and hardware-in-the-loop simulations are performed. For this purpose, different sub-models are combined in a simulation platform for VTOLs.

Based on the open RISC-V instruction set architecture, architectures are tailor-made and certified according to »ISO 26262 ASIL-D ready«. Monitoring of the environment and the safety-relevant components as well as the overall system by algorithms is indispensable. Commissioning, control and monitoring is performed by a 5G ground control station that takes relevant external information into account.

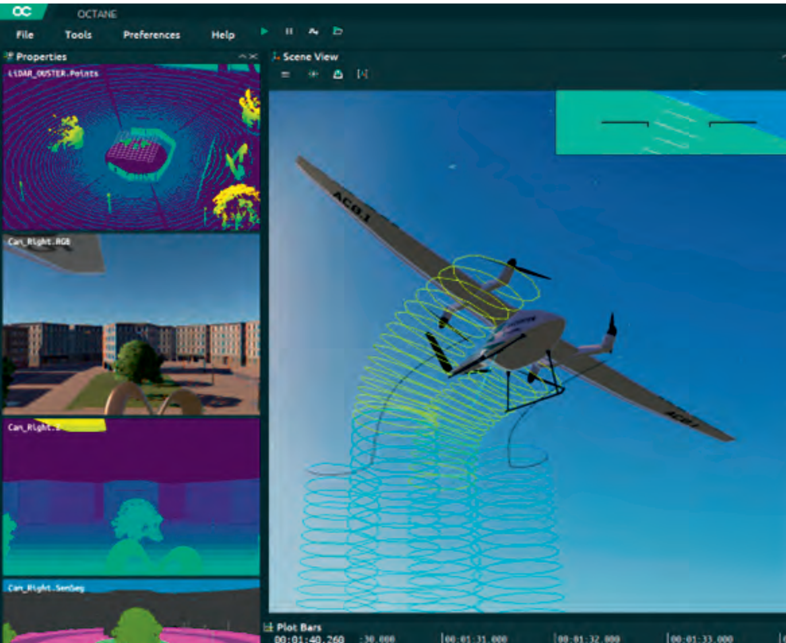
Within the project, AI-based solutions for environment recognition, trajectory planning and decision making are created. Together with the designed sensor systems, the capabilities of a human pilot will be substituted in the future and a modular autopilot suite will be created.

Digital twin

By means of a digital twin, technologies can be tested in early development phases in the overall use case, but also for rare and critical scenarios.

For this purpose, a virtual image of the ALBACOPTER® is created during the development process on the basis of the Fraunhofer OCTANE simulation platform (www.octane.org) and validated using real data - from flight dynamics and drive technology to E/E system, sensor technology and AI to realistic environmental scenarios.

The models developed are elaborated and evaluated by experts from the participating Fraunhofer institutes. Applications include the hardware-in-the-loop simulation of powertrain and control electronics as well as the training and testing of AI. The models are flexibly available for further applications beyond the scope of the project.



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