Flying
to the Limits

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The safe flying range of modern aircraft is determined not only by aerodynamic and structural limits, but increasingly by limitations of the system's technology. In order to stay within these limits and not overstrain the individual subsystems of flight control, developers observe sufficiently large safety margins. Currently, these safety margins, or performance reserves, of a highly automated flight control system can not be put to practical use and present a high potential for innovation. The Hamburg University of Technology has initiated its ULTRA project (Unmanned Low-cost Testing Research Aircraft) to analyze new approaches for staying within the flying range and make the performance reserves available for use without compromising safety. For this project, the university uses a professional test infrastructure for virtual and real test flights.
The development and tests of the necessary algorithms can be understood as rapid control prototyping in aviation.

SIL and HIL Simulation with dSPACE
A validated flight simulation environment based on MATLAB®/Simulink® lays the foundation for the model-based analysis and design of the important software components.
For this, the university has a powerful laboratory infrastructure with a dSPACE real-time system at its core. In addition to the flight dynamics model of the test plane, the real-time simulation also includes environment, system and sensor emulation models. Depending on the degree of integration of real system components (test flight computer, sensors, actuators, etc.), the new functions for staying within the flying range are tested via model-in-the-loop (MIL), software-in-the-loop (SIL) or hardware-in-the-loop (HIL) simulation.

Test Plane with dSPACE MicroAutoBox on Board
An HK36R Super Dimona on a scale of 1:3 is the unmanned test vehicle used to evaluate the functions for staying within the flying range in the real test flight.
A dSPACE MicroAutoBox on board the HK36R makes it easy to use the algorithms developed in MATLAB/Simulink on the test plane.
Different sensors are connected via a CAN data bus, e.g., for capturing the relevant aerodynamics variables such as speed, attitude, position, angle of attack, and sideslip angle. The MicroAutoBox communicates with the flight control system via pulse width modulation (PWM).

Mobile Ground Station for Real Test Flights
During the test flights, data is sent to a mobile ground station via a telemetry link. Specially developed tools make it possible to plan, control, and monitor the test flights and analyze the received telemetry data. Modern display designs let the pilot and test flight engineer capture critical flight parameters fast.