EASA
European Union Aviation Safety Agency

Monitoring of flight control laws

Contractor

Liebherr

Consortium Members

TU Berlin

Contract period

04/10/2022 - 03/10/2024

Budget

670 000€

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Main objectives:

Flight control laws are growing increasingly complex, making it challenging and, at times, impossible to compare and address integrity aspects and detect errors with dissimilar control laws. Typically, flight control systems feature various modes, such as the 'Normal Mode' with complex functions and protections, and lower-level modes like 'Direct Mode' with degraded functionalities. This research project specifically focuses on monitoring the control laws within the 'Normal Mode.' Currently, assurance in control law development heavily relies on robust development processes to instill confidence in disciplined development, minimizing the likelihood of errors affecting aircraft safety. However, this approach only mitigates, not eliminates, development risks, and latent errors may persist until they manifest. The project seeks to explore the implementation of flight control law monitors for error detection. Its objectives include enhancing EASA certification standards and facilitating the evaluation of new designs proposed by aircraft manufacturers.

the main challenges for the use of multiple monitors:

- **Effective Detection**: The efficacy of detection relies on the independence of the monitoring means from the item being observed.
- **Optimized Thresholds**: Designing independent monitoring involves establishing thresholds and confirmation times. These parameters must be calibrated to strike a balance—sufficiently low to avoid unnecessary triggers and not excessively high to prevent overlooking genuine issues.
- **Behavioral Interpretation:** Distinguishing between aircraft responses stemming from flight control law errors, normal behaviors in specific flight phases, or external perturbations can be challenging when monitoring aircraft behavior.

By addressing these challenges, the project aims to enhance the reliability and precision of multiple monitors in the aviation context

Impacts & benefits

The project involves creating a simulation environment for a large aeroplane's flight control system. It will assess proposed solutions for effectiveness, robustness in diverse scenarios, and the implementation effort.

Technical workshops for stakeholders like manufacturing industries and research centers will be conducted to showcase project objectives and results, encouraging collaborative feedback..

This project has been funded from the European Union's Horizon Europe research and innovation programme.

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Further reading

Fly-by-wire (FBW) systems, now the standard for modern large commercial transport airplanes, represent a paradigm shift in aviation technology. Their adoption has not only significantly enhanced aircraft safety and performance but has also been a cornerstone of the substantial progress achieved in civil aviation over recent decades. Beyond their application in traditional aircraft, FBW systems are indispensable for the development of vertical take-off and landing (VTOL) aircraft. These systems play a vital role in rendering such unconventional aircraft flyable. Moreover, they contribute to the automation and simplification of operations for modern air vehicles, setting the stage for increased autonomy. As we look to the future, the continual improvement of FBW systems emerges as a linchpin for advancing aircraft capabilities, ensuring safer and more efficient flight, and laying the foundation for the next generation of aviation technologies.

The project addresses the increasing complexity of flight control laws, highlighting the challenge of comparing dissimilar laws to detect errors. It emphasizes the reliance on development assurance processes to minimize system development risk but acknowledges their limitations in detecting latent errors. The research project focuses on monitoring 'Normal Mode' control laws, aiming to introduce flight control law monitors for error detection, improve EASA certification standards, and support the evaluation of new aircraft designs.

The primary aim of the project is to explore viable independent monitors for flight control laws. This involves identifying potential errors in control laws and determining their criticality. The project aims to propose multiple monitors for error detection, prioritizing effectiveness without immediately considering the associated effort required.

The main challenges are that:

- the detection is effective when the detection means are sufficiently independent from the item being monitored;
- the independent monitoring needs to be designed with thresholds and confirmation times set not so high as to not trigger when not needed, and also not so low as to lead to spurious detections; and
- it may be difficult from monitoring the aircraft behaviour to determine whether the aircraft response comes from a flight control law error, a normal behaviour in a given phase of the flight, and/or an external perturbation.

An aircraft model representative of modern large transport aircraft will be established comprising flight dynamics and flight control laws, flight control computers, actuators, sensors, etc... The model will serve as a platform to evaluate the monitors proposed, enabling the performance of state-of-the-art flight dynamics simulations covering the standard stability and control parameters and allowing the simulation of different aircraft configurations and flight manoeuvers or phases.

The test conditions to demonstrate the effectiveness of the monitors and test conditions for which the proposed monitors should be shown to be robust need to be defined.

The anticipated result is the identification of suitable independent monitors capable of detecting errors without adversely affecting the availability or operation of the flight control system in Normal Mode.

This project is part of the portfolio of EASA managed research projects funded under the European Research Programmes. Projects under this portfolio address research needs of civil aviation authorities and are geared to generate mid-term benefits after the successful completion of the project to enhance safety, security and sustainability.

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