

ASSESSMENT OF LIDAR-BASED TECHNIQUES TO MEASURE IN-FLIGHT DEFORMATION OF AEROSPACE STRUCTURES.

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Abstract

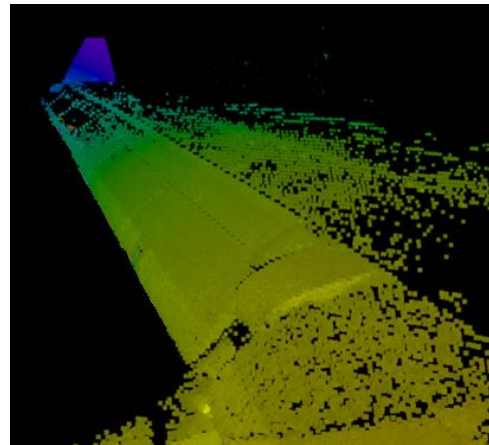
In the field of aerospace testing, extensometers, accelerometers, and photogrammetry are the traditional technologies used to measure deformations in aircraft components such as high aspect ratio wings, providing valuable data for aeroelastic design. Nevertheless, the integration of those traditional techniques in an aircraft throughout a flight test campaign, can be unfeasible by financial or logistic reasons. In that context, car LiDAR-based techniques emerge as promising alternatives for gathering in-flight deformation data of aerospace structures.

Therefore, this paper faces the challenge of assessing a car LiDAR as a flight-testing technology, less intrusive and more operationally efficient, to monitoring the flexion and torsion of an aircraft wing through a complete flight test campaign. Previously, the technology has been validated on a wing mock-up with experimental and numerical data.

In particular, the feasibility of the LiDAR-based techniques to effectively characterize the in-flight steady deformation, and the in-flight transient motion due to external perturbations, has been evaluated. For that purpose, a car LiDAR was installed within the A330-MRTT fuselage, in a non-invasive position. The LiDAR measured the A330-MRTT wing static deformation shape, so called 1G shape, and the dynamic response of the wing through the closest A/C window.



A. LiDAR system installed within the A330-MRTT fuselage.



B. Output of the LiDAR system: 3D point cloud

The LiDAR functions by scanning its surroundings with one or more laser beams, which are steered precisely to cover its field of view and reflected by the environment back to the scanner. These reflections are transformed into electronic signals by a photodetector, which are then filtered and processed. A 3D point cloud corresponding to the scanned environment as well as the intensities of the reflected beams constitute the output of a LiDAR system.

The development of clustering algorithms and fusion with camera images has been fundamental to properly measure the wing torsion box deformation throughout the complete flight, allowing the capability of successfully tracking the requested monitored points.

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In summary, this paper describes all the activities performed to assess the feasibility of LiDAR-based techniques for measuring the in-flight deformation of the A330-MRTT wing, together with flight test results, theoretical validation, and lesson learnt obtained.