Mitteilung

Fachgruppe: Experimentelle Aerodynamik

Optical deformation measurement for load monitoring on a scaled flight test vehicle

J. Wagner*, T. Kirmse*,
O. Luderer† , F. Thielecke†,
W. Gropengießer‡, S. Adden‡

* German Aerospace Center, Institute of Aerodynamics and Flow Technology, Bunsenstr. 10, Göttingen, Germany
† Hamburg University of Technology, Institute of Aircraft Systems Engineering, Nesspriel 5, 21129 Hamburg, Germany
‡ IBK Innovation GmbH & Co. KG, Butendeichsweg 2, Hamburg, Germany
jan.wagner@dlr.de

Various measurement parameters, such as acceleration, strain, pressure data, and deformation, can be used to monitor loads on aircraft wings. Here, deformation is recorded optically using a stereo camera system. Two different measurement systems are used for this purpose:
The Image Pattern Correlation Technique (IPCT) is an established, well-proven method for measuring 2.5D surface deformations based on a random distribution of points on the surface. This method achieves high accuracy (~ 0.2 pixels), but is computationally intensive and not suitable for real-time applications. (Boden et al. 2013)
In contrast, marker-based measurement is fast and efficient and can also be performed with a single camera. The four corners of the marker enable the position in space to be determined using a separate marker coordinate system, but only at discrete points. Here, a further development (Enhanced ArUco Marker) of the widely used ArUco markers is used, which provide better subpixel accuracy thanks to their checkerboard frame (Garrido-Jurado et al. 2014; Kedilioglu et al. 2021), see Fig. 1. Preliminary tests have shown that a stereo camera system offers greater accuracy than a mono camera marker recognition system. (Kedilioglu et al. 2021).

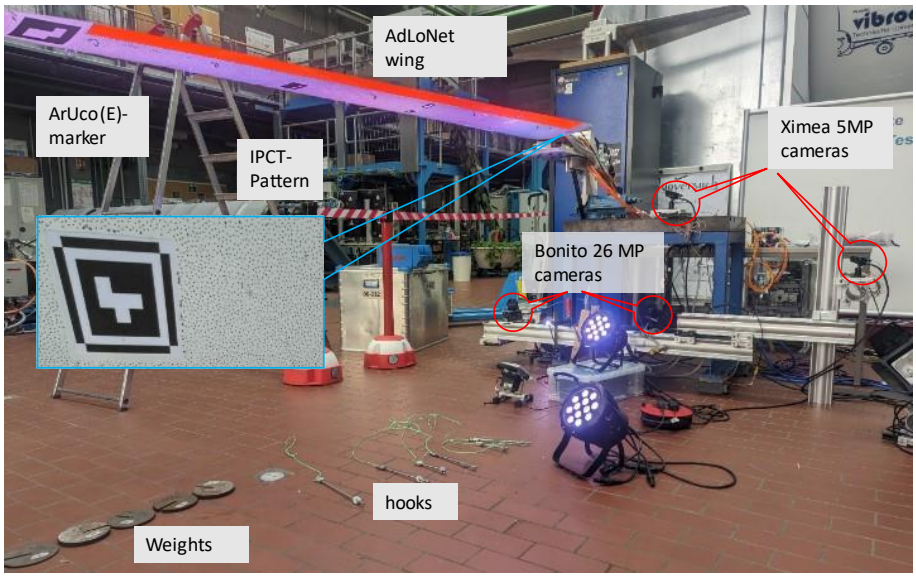

Fig. 1: Calibration setup with the two stereo camera systems (26 Mpx Bonito, 5 Mpx Ximea), as well as the IPCT pattern and the Aruco(E) markers. The weights for the wing loading are on the floor.

The aircraft used is the AdLoNet-Dimona, a scaled test aircraft from the TUHH with a wingspan of 2.5 m and a payload of approx. 4 kg at a total weight of 25 kg, whose right wing is equipped with strain gauges and acceleration sensors for load monitoring. (Luderer et al. 2023)

The aim is to compare the two optical measurement systems with each other and with the other sensor results, and to assess their suitability for use in measurement environments with severe restrictions in terms of optical accessibility, installation space, weight, and electrical power. For this purpose, the data from the static calibration test will be used, as well as the wind tunnel measurement, which was also carried out, but where only the 5 Mpx Xiema cameras were used for optical measurements, see Fig. 2.

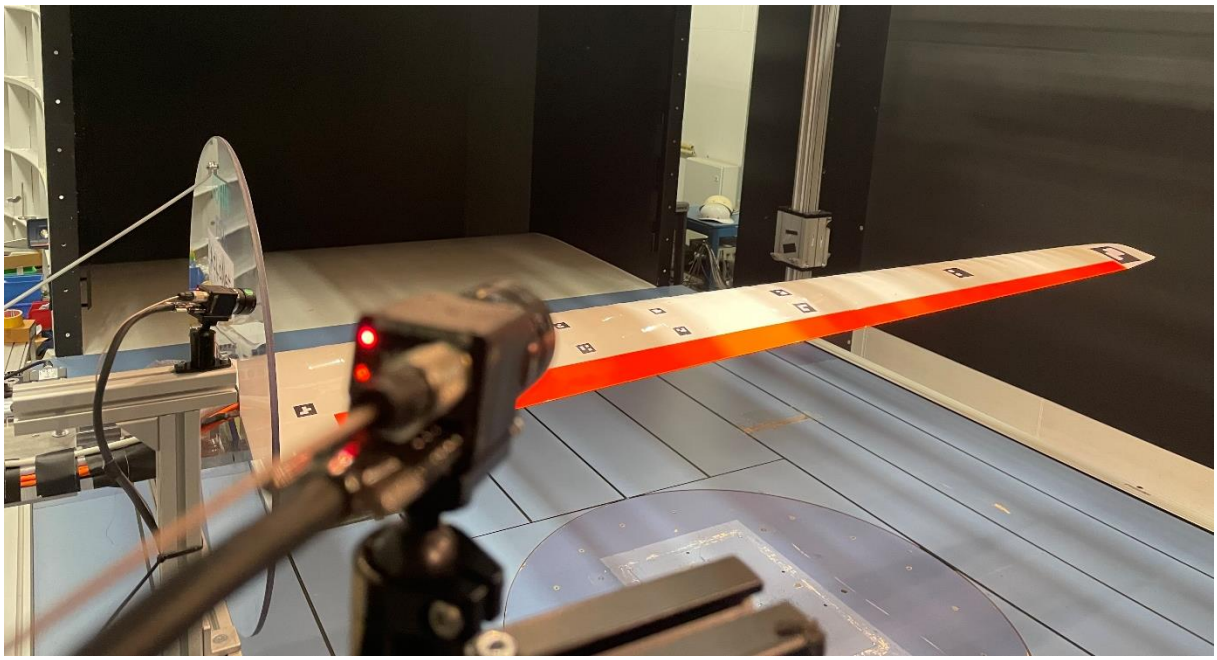

Fig. 2: Wing in the wind tunnel with the markers and the two Ximea 5 Mpx cameras. The other sensors are installed in the wing.

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