Structural Health Monitoring of Adaptive Aerospace Structures

Nazeer, N.

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Structural Health Monitoring of Adaptive Aerospace Structures

PhD Candidate: Nakash Nazeer
Department: ASM
Section: SI&C
Supervisor: Dr. R.M. Groves
Promotor: Prof.dr.ir. R. Benedictus
Contact: N.Nazeer@tudelft.nl

1 | 2 | 3 | 4

Objective

To design and develop a smart sensing-system for load monitoring, shape sensing and damage detection on a morphing wing structure.

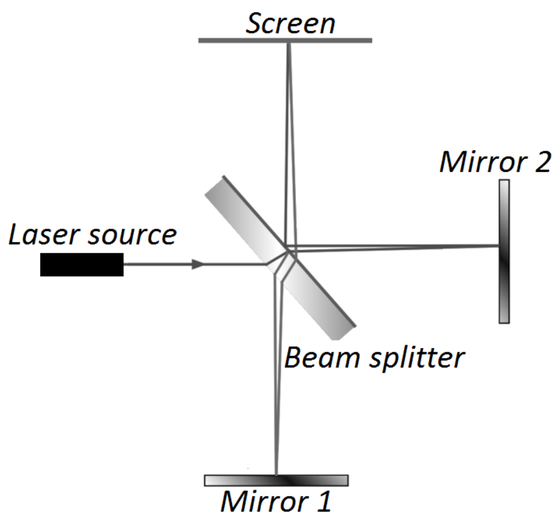
Introduction

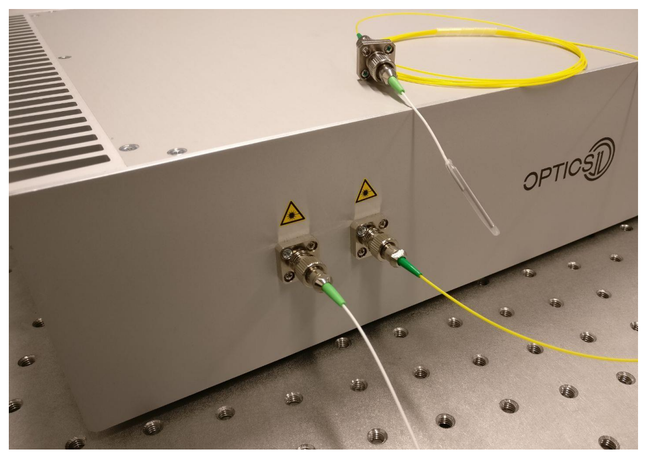
Wing-morphing technology is undoubtedly the future of aircraft design. Taking inspiration from birds, these wings are multi-role structures that can change their shape in order to fulfill different mission requirements during flight. In other words, a single flexible structure that delivers the desired motion by undergoing elastic deformations.

There is a growing need for active inflight structural health monitoring of such wings with the advent of these technologies. The system needs to be light, accurate, fast and reliable. This project focusses on using Fibre Optic sensing technologies to build this system.

Interrogator Principle

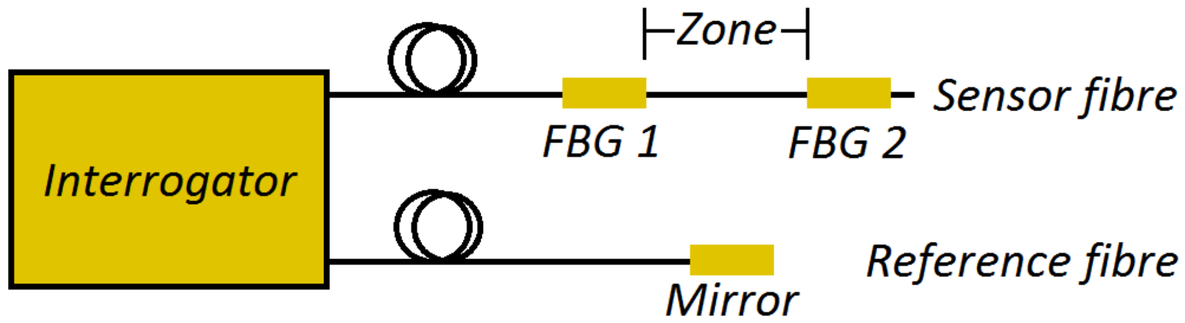
Measurements are carried out by the Optics11 ZonaSens interrogator, at the heart of which is a Michelson interferometer. A laser beam passes through a beam splitter which splits it into two identical beams. One beam is transmitted through while the other gets reflected, as shown in the schematic. Each beam travels down an arm of the interferometer at the end of which are mirrors that reflect them back to the beam splitter. The incoming beams merge together and the resultant is measured at the screen.





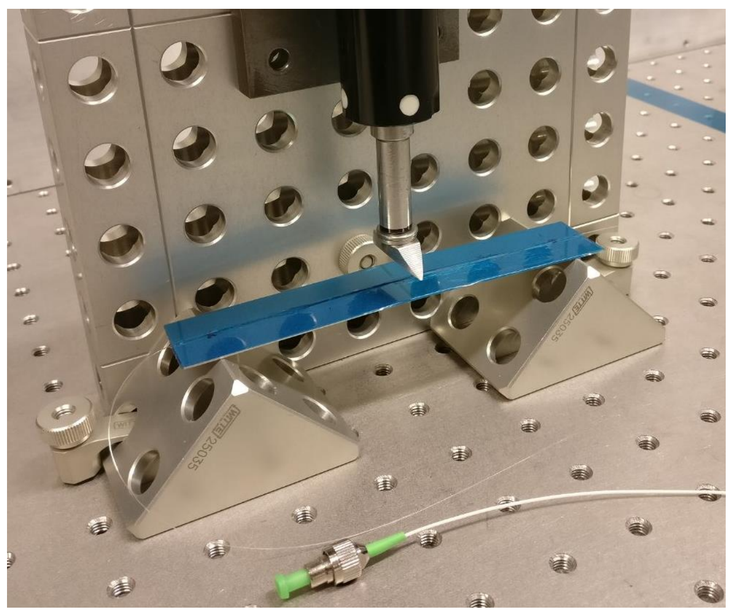
The yellow (reference) fibre and white (sensor) fibre coming out of the interrogator box represent each arm.

Sensing Principle



The ZonaSens uses a novel interferometer sensing principle to define zones between two Fibre Bragg Gratings (FBG). The slightest change in distance within a zone due to structural displacements or acoustic signals is calculated and retrieved with high speed nanoscale precision.

Experimental Setup



A 3-point-bend test rig is set up for preliminary tests. The goal is to study the effect of structural displacement on a bonded fibre optic sensor using this principle.

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