

# Technique for Monitoring Fatigue of a Shape Memory Alloy Actuator

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## Technology description

Canadian Space Agency (CSA) - Shape Memory Alloy (SMA) Actuators are used in a wide range of industries and applications. Typically, SMA's are used as an on / off actuators. A major challenge for SMA actuators is fatigue resulting from multi-cycle applications. Fatigue is primarily attributable to mechanical fatigue of the material and the gradual loss in the shape memory effect which is further complicated by the presence of martensitic phase transformation. The consequence of fatigue is the gradual loss of actuation position control, i.e. SMA actuator can no longer achieve its original, desired position. Too much fatigue beyond an acceptable margin results in a dysfunctional SMA actuator.

Previous attempts were made to characterize fatigue or use electrical resistance as feedback to control the SMA actuator and prevent fatigue; however, NONE of these attempts included an actual in-situe monitoring of the fatigue. The invention is based on monitoring the stress and the electrical resistance of the SMA element. The control system is adapted to compare an electrical resistance exhibited by the SMA element in an Austenitic phase during the first actuation of the SMA actuator, with the electrical resistance of the SMA element in a recent austenitic phase, in order to estimate the degree of fatigue. This estimate can be used to compensate for the effect of fatigue and improve actuator replacement schedules.

## Commercial Potential

This technology may be employed in a wide range of applications where SMA based actuation is desirable, and where both ON/OFF and fine position control is required. These applications include but are not limited to:

- Morphing wing and engine structures;
- Helicopter rotor blade angle control;
- Artificial muscle in next generation space and robotic systems;
- Actuator for various type of switches and valves;
- Dynamic precision control of tension and position in mechanical systems;
- Thermostatic drive for smart louver for satellite thermal control subsystem;

- Actuator for tensioning control of membrane synthetic aperture radar (SAR) antennas;
- Automotive fuel injection systems.

## The Business Opportunity

SMA actuators are a fast growing market, whereby the CSA's invention addresses a plethora of applications across numerous industries. Competition is increasing in the SMA market through a growing number of small and flexible suppliers. Maintaining a competitive advantage with technologies that can cross-cut into other applications provides both stability and room to grow. The CSA aims to contribute to growth of Canadian industrial players through partnerships that enable the transfer of this invention to the most suitable of candidates.

## Technology Transfer Details

A commercialization licence is available for this technology.

The technology may be referred to by its CSA case ID: **51106**

## Advantages

- Simple;
- Cost-efficient;
- In-situ & real-time monitoring;
- Ensures operational continuity;
- Greater position control;
- Broad addressable applications;
- Proven tests for typical SMA actuators.

## Institution

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