

Thesis Title	Online Diagnosis System for Fatigue Detection of a SMA-based Control Valve
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Abstract

This work describes a functional fatigue detection system for a nonlinear SMA-based control valve. Any drift from the normal behavior of the valve is revealed using a model-based residual generator by mean of a nonlinear auto-regressive with the eXogenous input (NARX) model.

The experimental results suggest that the variances of one-step-ahead (OSA) error and model predicted error (MPE) are a good indicator of fatigue states of the online diagnosis for the tested control valve. The three fatigue levels are identified offline by k-means clustering using the estimated parameters of the NARX model in conjunction with the statistical properties of the MPE as features. Based on the optimisation property of cumulative sum (CUSUM) and adaptive (CUSUM), an online system for detecting changes in variance of residuals due to fatigue of the valve is developed. The results in experiments show that the fatigue levels of the SMA-based control valve can be identified and diagnosed by the above method. Furthermore, only by selecting an appropriate value of the parameter beta, one can apply the developed adaptive CUSUM algorithm to indicate the fatigue level of the valve online.

Keywords : Functional Fatigue / Shape Memory Alloy / Control Valve / CUSUM / NARX Model.