AI BASED SHOCK-WAVE DETECTION BY USING A PRESSURE SENSOR ARRAY

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The continuous expansion of intelligent systems has increased the demand and development of sensor devices with self-diagnostic and prognostic features [1-3], often working in full-authority control systems. Moreover, new diagnostics and health monitoring applications, as well as the development of Digital Twin concepts push toward the use of large numbers of real/virtual sensors embedded in the system to be monitored. The use of spatially distributed sensors allows to extract information of very complex nature. In the proposed case the focus is on the detection and location of a shock-wave inside a supersonic duct.

Supersonic aerospace propulsion systems deal with shocks inside the air-intake, which are characterized by nonlinear dynamics [4]. The shock must be actively controlled, by minimizing intake losses and avoiding inlet unstart. Lower intake losses also mean narrower stability margins for the shock. A robust active control requires an efficient and well resolved detection of the actual shock position inside the air-intake.

The general problem of detecting the position of a shock by using a discrete set of real or virtual pressure sensors is studied numerically. A Machine Learning (ML) algorithm [5] is trained by CFD simulations of the transonic flow in a duct with an embedded shock-wave at different positions. The shock-wave detection algorithm is then validated by using discrete data collected at different duct locations, to simulate the outputs of a discrete number of pressure sensors placed along the duct. A noise model and randomly wrong pressure values are introduced in order to emulate the sensors' outputs and faults. The algorithm effectiveness is analyzed for different sensor precisions.

References

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