Flow Regime Identification by a Self-Organising Neural Network

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Abstract

One of the prerequisites of effective operation of multiphase flow systems is the need to identify flow regimes. A number of flow regime classification models have been reported in the literature based on the subjective and ambiguous interpretation of visual observations. With the advent of microprocessors and recent advances in signal processing, pattern recognition and neural network techniques, we are now on the threshold of finding more objective and quantitative technique for flow regime identification and flowrate measurement in multiphase systems. This paper presents a technique for the classification of flow regimes in horizontal air-water two-phase flow lines by the application of the Kohonen self-organising feature map (KSOFM).

The principle of the technique rests on the characterisation and classification of turbulent pressure signals in relation with flow regimes. Characterisation means deriving stochastic features from time domain signals which are likely to be associated with specific physico-fluid dynamic groups based on space-time average values. Classification means defining the boundaries of the fluid regimes as represented by the fluid dynamic groups.

KSOFM is known to be capable of organising patterns from an arbitrary n-dimension space into lower dimension space and preserving the topological relationships among the features. In this case, a KSOFM with 8*8 neurons was selected and trained with stochastic features derived from the absolute pressure signals obtained from a range of flow regimes. The resulting feature map succeeded in organising samples from similar flow regimes into same or adjacent neurons and separating samples from different flow regimes into different areas.

The samples used in the tests were obtained in laboratory measurements conducted in a horizontal 2 inch diameter air-water flow line. KSOFM identified the flow regimes observed visually as bubbly, slug and wavy/stratified flow regimes as well as the more elusive transition regimes. For future work, it is proposed that the KSOFM offers a pre-processing capability in separating training regions into sub-regions where within each sub-region other supervised network models, such as the back propagation neural networks can be trained to identify primary quantities of interest such as average mass/volumetric flow rates of individual phases.

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