COMPARISON OF MACHINE LEARNING TECHNIQUES FOR PREDICTION OF ENTRAINMENT OF SEDIMENT PARTICLES

Manousos Valyrakis, Virginia Tech, 304-994-2082, mvalyrak@vt.edu

1. Manousos Valyrakis, Virginia Tech

The entrainment of coarse bed material in river beds is a non-stationary and intermittent process at relatively low mobility flow conditions. The use of a neuro-fuzzy model is proposed to predict the instances of sediment particle mobilization by rolling. The modeling approach is based on the postulation that particle entrainment is triggered by coherent near bed flow events of varying spatial or temporal scale and energy content impinging on it. This hypothesis is examined by employing several machine learning tools that utilize long time series of synchronously obtained input-output pairs, in an attempt to connect the rapidly fluctuating flow forcing to the particle's minute displacements.

The experimental setup consists of a laser Doppler velocimeter (LDV) and an optical setup which acquire data concurrently. The first is used to record the flow velocity components directly upstream of the test particle, while the later track the particle's displacements. The experimental data sets, the length of which ranges from several hundred thousand to about a million, is split into the training and validation subsets used to perform the corresponding processes.

Various soft-computing approaches are employed ranging from artificial neural networks (ANNs) to adaptive neuro-fuzzy inference systems (ANFIS). A number of architectures of increasing complexity are built to model the hidden dynamics of the highly nonlinear system. These are compared in terms of different error and performance indices, computational efficiency and complexity as well as predictive accuracy and forecast ability. Depending on the representation of the input-output pairs fed into the developed algorithms several of the trained and tested architectures perform very well in simulating particle entrainment dynamics.

It is shown that overall the ANFIS, incorporating the benefits of both human like reasoning (fuzzy inference, If-Then rules) and intelligent learning (adaptive neural networks), outperforms the other techniques. In addition, it is shown how empirical knowledge can be extracted from the trained model, validating the theory and expanding its application in generic cases.