MODELING THE DYNAMIC BEHAVIOURS OF FRANCIS TURBINE RUNNER OVER DIFFERENT STEADY-STATE OPERATING CONDITIONS

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ABSTRACT

Current power systems must adapt to new requirements leading to the need for a better understanding of dynamic behaviors across the full operating range of hydroelectric turbines, especially to assess the impact on the life of critical components like runner blade. However, this information cannot be fully obtained due to limited experimental measurements. Therefore, our research aims to create prediction models which can interpolate or extrapolate the strain/stress signal to generate data over any operating conditions and time duration.

Four approaches have been applied to a case study using on-site measurements from a Francis turbine located in Québec, Canada. The first strategy is to uniquely predict extreme values of the signals which are represented by an extreme distribution and a threshold (Peaks-Over-Threshold technique). The second one is to model directly the rainfall counting matrix containing the fatigue loading information. The third one is to decompose the signals and independently interpolate each component. In such case, the components are extracted using cyclostationary decomposition operators. For all three methods, an interpolation method from the kriging family (Ordinary kriging, Cokriging, etc.) is used to perform the prediction at a given operating condition. The use of kriging allows not only an optimal linear predictor but also an assessment of the uncertainty of a given estimate. Such methods need more human resources. Hence, a fourth strategy was explored to automate the process. This fourth strategy uses neural networks to learn from available data in order to generate new signal realizations at any desired operating conditions. The goal of each of those models is to extend the concept of virtual sensors which could potentially generate realistic data for prognostic over any operating scenario in the absence of observations.

In this presentation, our goal is to give an overview of our current results and provide a comparison between these strategies developed in which more classical approach like kriging interpolation can be compared to more modern ones like machine learning. Their prediction performances, their advantages/disadvantages and future development will be discussed.