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COMO1#2 - Automatic Processing of Air Gap Monitoring Signals in Hydro-Generators

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In run-of-the-river hydroelectric power plants, compact turbines are typically used to minimize disturbance to the river flow and preserve the ecosystem. However, compact turbines are often designed at the cost of a small air gap which can lead to rotor-stator collisions. Such accidents lead to a temporary halt in production, can cause collateral damage and are very expensive to repair. Air gap monitoring is therefore the best solution to predict and prevent such collisions. Due to recent industry needs, we consider the case of stator deformation with dynamic rotor eccentricity. Specifically, we opt for a set of capacitive sensors attached to the rotor to monitor the air gap (wireless transmission) and a set of displacement sensors to monitor the rotor eccentricity (wired transmission). Each set is associated with a keyphasor. However, if the literature in the field of air gap monitoring is rich in sensor instrumentation, it is rather poor in signal processing, especially for the case of rotor deformation. In this work, we take a first step to fill this gap and propose a solution to automatically process the recorded signals. After resampling the signals in the angular domain, a first classic step is to consider the cyclo-stationary properties of the recorded signalÌ€s. The first order component provides a denoised signal while the second component can quantify its relative strength. Next, we present two main results. (1) We show how to compute the stator profile by correcting the eccentricity of the measured air gap, which is useful for long-term maintenance. (2) For each point of the stator, we calculate the critical air gap that corresponds to its closest position to the rotor which is essential to protect the turbine in real time. Furthermore, this solution allows to considerably reduce the size of the data, thus facilitating its storage. Finally, we propose visualizations that can be interpreted by experts in the field who have no prior knowledge of the techniques used. In particular, we display the rotor trajectory and the 3D stator deformation map while displaying the acyclic noise strength to provide insights on the reliability of the results.

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