

Physically Informed Kernels for Wave Loading Prediction

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Abstract : Wave loading is a primary cause of fatigue within offshore structures and its quantification presents a challenging and important subtask within the SHM framework. The accurate representation of physics in such environments is difficult, however, driving the development of data-driven techniques in recent years. Within many industrial applications, empirical laws remain the preferred method of wave loading prediction due to their low computational cost and ease of implementation. This paper aims to develop an approach that combines data-driven Gaussian process models with physical empirical solutions for wave loading, including Morison's Equation. The aim here is to incorporate physics directly into the covariance function (kernel) of the Gaussian process, enforcing derived behaviors whilst still allowing enough flexibility to account for phenomena such as vortex shedding, which may not be represented within the empirical laws. The combined approach has a number of advantages, including improved performance over either component used independently and interpretable hyperparameters.

Keywords : offshore structures, Gaussian processes, Physics informed machine learning, Kernel design

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