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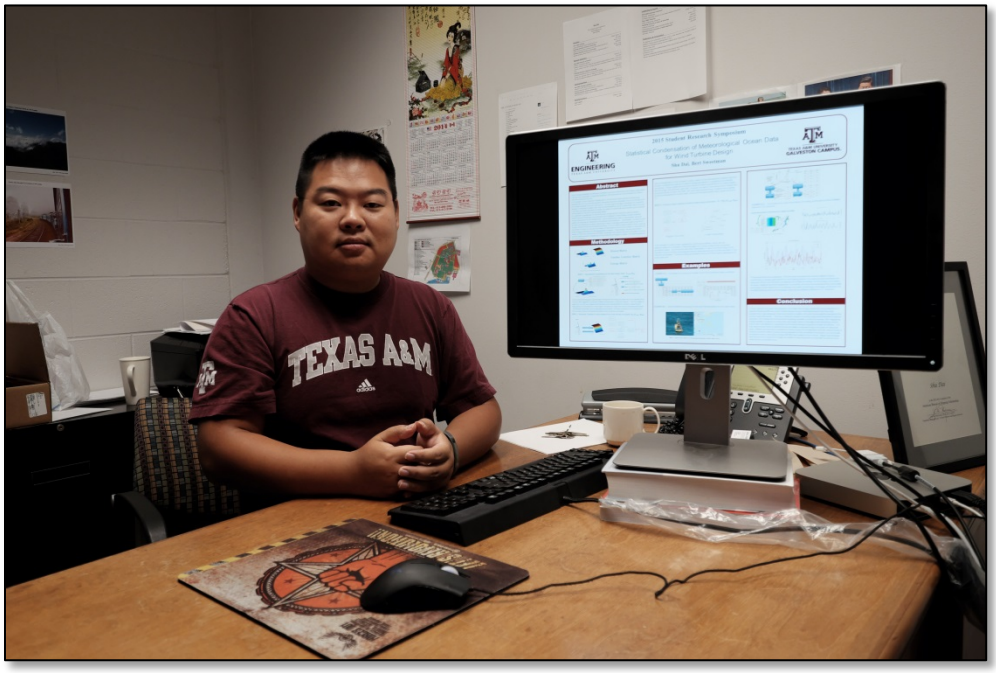
Statistical Condensation of Meteorological Ocean Data for Wind Turbine Design



Optimizing profitability of offshore wind farms requires matching those design parameters that can be controlled in engineering design with operational environmental conditions that are unique to the site. In this paper, a new method is presented in which the environmental conditions are represented as only two site-specific dependent random variables: the wind velocity and the angle between the wind and waves. Computing the energy harvested for a specific design in a specific location can then be accomplished using substantially less computer time than would be required for direct simulation of performance considering all possible combinations of environmental parameters. An example is presented in which the new condensation method is used to assess performance of floating wind turbines at four different Unites States coastal locations using measured environmental data. A joint-distribution matrix is developed using an extensive data set of measured wind speeds and directions. Separately, numerous time-domain simulations are used to develop a matrix of energy production spanning the full range of observed environmental conditions. The simulation-based matrix is then used as a transfer function to convert the matrix of historical wind and wave data to a prediction of total energy production for that geographic location. Total energy harvest predictions based on the new method are critically compared with direct long-term simulation of wind turbine performance in measured environmental conditions to assess the effectiveness of the new method.

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