PI controller design of a wind turbine: evaluation of the pole-placement method and tuning using constrained optimization

PI/PID controllers are the most common wind turbine controllers. Normally a first tuning is obtained using methods such as pole-placement or Ziegler-Nichols and then extensive aeroelastic simulations are used to obtain the best tuning in terms of regulation of the outputs and reduction of the loads. In the traditional tuning approaches, the properties of different open loop and closed loop transfer functions of the system are not normally considered. In this paper, an assessment of the pole-placement tuning method is presented based on robustness measures. Then a constrained optimization setup is suggested to automatically tune the wind turbine controller subject to robustness constraints. The properties of the system such as the maximum sensitivity and complementary sensitivity functions (Ms and Mt), along with some of the responses of the system, are used to investigate the controller performance and formulate the optimization problem. The cost function is the integral absolute error (IAE) of the rotational speed from a disturbance modeled as a step in wind speed. Linearized model of the DTU 10-MW reference wind turbine is obtained using HAWCStab2. Thereafter, the model is reduced with model order reduction. The trade-off curves are given to assess the tunings of the poles-placement method and a constrained optimization problem is solved to find the best tuning.

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