Regarding the qualitative and quantitative results against step wind, similar conclusions can be obtained: the designed controller obtains a better CVR_{x_t} and $ITAE_{x_t}$ index values, reducing such index values in a 32.06% and 58.04%, respectively, in comparison with those of the baseline controller. With respect to the $IAE_{\omega g}$ and $ITAE_{\omega g}$ index values, the designed controller reduces these indices in a 91.3% and 81% respectively, compared to the baseline controller.

5. Conclusions

An adaptive wind turbine control structure operating on the pitch variable in the nominal zone is developed in this work. The proposed control strategy mainly combines two control loops: the first one to maintain the wind turbine speed in its nominal value and the second to reduce the f-a tower displacements. The gain-scheduling I-P controller with adaptive feedforward regulates the turbine speed by actuating on the pitch angle, and the active tower damping control generates an extra pitch control component proportional to the tower fore-aft velocity reducing the structural fatigue of the tower. The tuning procedure of the PI controllers with fore-aft control is performed by means of a multi-objective genetic algorithm seeking to minimize the tower fore-aft displacements and the deviation of the wind turbine speed from its nominal value.

The proposed controller is compared with a classic adaptive controller using different wind conditions. The simulation results show a significant improvement in the performance of the designed controller for both step and stochastic winds, improving the reference tracking of the turbine angular speed and mitigating the tower f-a oscillations in comparison with the baseline controller.

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