

Robust load frequency control using an improved tilted integral derivative controller in interconnected diverse unit networks

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Abstract

Modern electrical power systems are expected to be dominated by various interconnected systems, furthermore, the incorporation of various renewables sources of energy into the power grid which increases the difficulty and load of the power system, a key indicator of modern power systems' safe and efficient performance is their frequency. Maintaining the frequency stability in an interconnected multi area power system has become more challenging and complex due to the reduced system inertia and high penetration of renewable energy resources. Conventional load frequency control techniques suffer from high overshoot, slow settling time and degraded robustness under various parameter uncertainties and various constraints that are nonlinear in a power system such as generation rate constant and governor dead band. This study proposes an improved tilted integral derivative controller for a heterogeneous multi area power system that contains a thermal plant, hydro plant and a gas unit. Various controller parameters are tuned using a one-to-one based population optimizer that minimizes the integral square error and integral time weighted absolute errors. The simulation results demonstrate that the proposed strategy reduces the settling time by approximately 40 percent when compared to the grey wolf optimization and 25 percent when compared to particle swarm optimization under identical conditions. The overshoot also reduces by 30 to 45 percent and also the tie line power oscillations are damped. Under integral time weighted absolute error tuning the settling time of area 1 frequency deviation is reduced from 25 seconds to 15 seconds in case of grey wolf optimization. Also, the controller also maintains stable performance under nonlinear constraints. The uniqueness of the proposed controller in the first application of the one-to-one based optimizer for tuning a cascade tilted integral derivative controller in multi area load frequency control, with the dual objective validation and robustness verification. The suggested method exhibits better damping properties and dynamic stability making it appropriate for contemporary low inertia linked power systems.

Keywords: Load Frequency Control (LFC); Fractional Order Proportional Integral Derivative (FO-PID) Controller; Tilted Integral Derivative (TID) Controller