Remedial Actions to Enhance Stability of Low-Inertia Systems

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Goal #1: Enhance transient stability of low-inertia systems through inertia and damping control

- Low inertia systems are more prone to instability.
- Increasing inertia and damping control during the fault-on dynamics increases the region of attraction.
- Synthetic inertia and damping can be provided by external sources.

Goal #2: Use a simulation-free approach

- Stability certificates: tractable sufficient conditions
- Strategy: certify security of most of scenarios with conservative conditions, use simulations for few really dangerous scenarios

Example: Energy Function

\[ E = \frac{1}{2} \omega^T M \omega + \sum \delta_i \cos \delta_i - \sum P_i \]

Contributions

- Exact reformulation to relax the LMI condition
- Optimal tuning of inertia and damping
- Problem is bilinear: Find \( (m,d) \)
- Robust: independent of the operating point (within bounds)
- Convex: quadratic functions
- Less conservative potentially: it's a family of Lyapunov functions
- Introduced exact reformulation to relax the problem and obtain better results
- Incorporated remedial actions:
  - Use of external power sources to mimic inertia and damping
  - Simulation-free stability guarantees for a larger set of faults
  - Low energy and power requirements: external sources act only during fault-on dynamics

Conclusions

- Presented stability and resiliency certificates that are:
  - Robust: independent of the operating point (within bounds)
  - Convex: quadratic functions
  - Less conservative potentially: it's a family of Lyapunov functions

Reference:


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