Towards Efficient and Effective Smart Grid Control

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Less CO2 emissions and a more reliably power system
Outline

• Background Information
• Method: PSO + Grid Search
• Simulation and Results
• Conclusion
What is a Smart grid

“… an electricity supply network that uses digital communications technology to detect and react to local changes in usage…”

Why do we need it

Decrease cost, waste, and response time:
- Easier add distributed generation and storage
- Coordination and Communication
- Detect errors
Challenges of Smart grid Optimization

- Uncontrolled production and demand
- New generation sources need to be able to be introduced easily
- Transient surges of power

Need for smarter controllers
What is: Particle Swarm Optimization

-A way of searching for an optimal point
-Originally based on a flock of birds
-Searches for best “food” location through communication
How: Particle Swarm Optimization

- Starts randomly and compares particles location to personal and global best
- Moves toward best location at partially-random velocity, overshoots, repeats

\[ V^{k+1} = W V^k + c1 \times \text{rand} \times (P\text{best} - x^k) + c2 \times \text{rand} \times (G\text{best} - x^k) \]

\[ x^{k+1} = x^k + V^{k+1} \]
Smart Grid Simulation Model

Home Load, Cloud Shading and Solar Panels, Generator, Controllers…
Simplified vs Realistic Models

Simple: 
Load put on the system

Realistic: 
Load put on the system, with the noise from distributed generation
PSO fitness vs. iteration

Simplified Model

Realistic Model
PSO vs Grid Search: Simplified Model

- Grid Search
  525.5 min

- PSO
  20.9 min (Over 26 times faster)

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<th>Time (min)</th>
<th>P</th>
<th>I</th>
<th>Fitness</th>
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<td>20.86</td>
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PSO vs Grid Search: Realistic

- Grid Search
  487.7 min

- PSO
  21.1 min (23 times faster)

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Conclusion

-Smart grid is the future of power systems

-It brings new challenges, such as frequency fluctuations

-Smart controllers can deal with these challenges through use of Particle Swarm Optimization
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