SCCER-FURIES

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SCCER-FURIES Annual Meeting, October 28th 2020

Dynamic Transmission System Emulator for Stability Assessment

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Introduction

Transmission grid instabilities

Control solutions to improve stability

Real time simulator

Simulations

Test solutions

Control in the loop

Design of new control chain

WADC

PMU(s)

PSS

Tuning of existing controls

APPENDIX A

<table>
<thead>
<tr>
<th>Time</th>
<th>Frequency [Hz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:18:00</td>
<td>Undamped oscillation of 0.15Hz</td>
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**Diagram Description:**

- **Transmission Grid Instabilities:**
  - Undamped oscillation of 0.15Hz

- **Design of New Control Chain:**
  - WADC
  - PMU(s)

- **Real Time Simulator:**
  - Control in the loop

- **Simulations:**
  - Test solutions

- **Control Solutions:**
  - To improve stability

- **Real Time Simulator:**
  - Control in the loop

- **Simulations:**
  - Test solutions

- **Control Chain Design:**
  - WADC
  - PMU(s)
Introduction

European model (entso-e):
- 6147 generators
- 23253 buses
- 7377 loads
- 3-4 areas

Kundur two-areas model:
- 4 generators
- 11 buses
- 2 loads
- 2 areas

New England model:
- 10 generators
- 39 buses
- 19 loads
- 2 areas
Outline

- Kundur’s Original Model
- Scaling in ZHAW Laboratory
- Some results
- Perspectives
- Conclusion

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The smallest representation of a transmission grid
- 4 generators
- 11 buses
- 2 loads
- 2 areas

Kundur’s original model

<table>
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<tr>
<th>Mode</th>
<th>Name</th>
<th>Real part</th>
<th>Imaginary part</th>
<th>Magnitude</th>
<th>Angle deg</th>
<th>Damped Frequency</th>
<th>Period</th>
<th>Damping</th>
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</table>
Scaling in ZHAW laboratory

**ZHAW laboratory**

**Original model**
Final implementation
Without inertia

Laboratory view

Settings
Effect of inertia

Laboratory view

Settings

Active Power [W]

Frequency [Hz]
Effect of inertia

Settings
Trip of a line

Laboratory view

Settings

Active Power [W]

Frequency [Hz]

200 W

G

Area 1

Area 2

G

G

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Trip of a line

Settings

200 W

Some results

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**PSS implementation**

From computer

- PSS Unitrol 1010
- AVR Unitrol 1010

**WADC implementation**

Meas from 1 or several areas

WADC Raspberry Pi
Conclusion

- Implementation of Kundur’s transmission grid model using Lucas Nüelle systems
  - Possibility to change inertia, to trip lines, to trip generators, to activate / deactivate secondary controllers...
  - Ability to represent inter-area oscillations as well as local oscillations
- Possibility to test some controllers already designed in simulation: