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A Continually Online Trained Neurocontroller for Excitation and Turbine Control of a Turbogenerator

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PowerPoint Presentation

A CONTINUALLY ONLINE TRAINED NEUROCONTROLLER FOR EXCITATION AND TURBINE CONTROL OF A TURBOGENERATOR

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Introduction

- The power grid is a complex and a variable network with many operational levels made up of a wide range of energy sources with many interaction points.
- As the demand for the electric power is outpacing the available sources, the complex systems that ensure the stability and security of the power grid are pushed closer to their edge.
- Turbogenerators supply most of the electrical energy and their performance is directly related to the stability and security of the power grid.
- A turbogenerator is a nonlinear, non-stationary, multivariable system.
- Conventional automatic voltage regulators (AVRs) and turbine governors are designed, based on some linearized power system model, to control the turbogenerator in some optimal fashion around one operating point. At other operating points the controller performance degrades.
- For large disturbances, these controllers operate outside the linear range and performance also degrades, thus driving the power system into undesirable operating states.

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This Paper shows the following:

- The design and implementation of a continually online trained (COT) neurocontroller and a COT neuroidentifier on a practical turbogenerator system test bed, using multi-layer perceptron (MLP) neural network.
- Both simulation and practical implementation results are presented in order to prove that the neurocontroller is stable when using *deviation signals* for *online training*.
- The drawback related to MLP neural networks compared to the RBF neural network, reported in references [8] & [10] in the paper, is overcome with the use of *deviation signals* instead of using the actual signals.
- It compares the performance of the neurocontroller with the conventional AVR and governor controllers but emphasizes on how to do neurocontrol with *online training* on a practical turbogenerator system.

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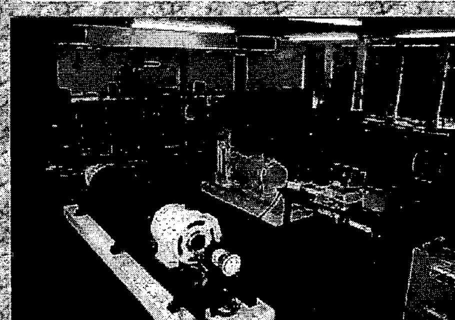
Micro-Machine Research Laboratory at the University of Natal, Durban, South Africa



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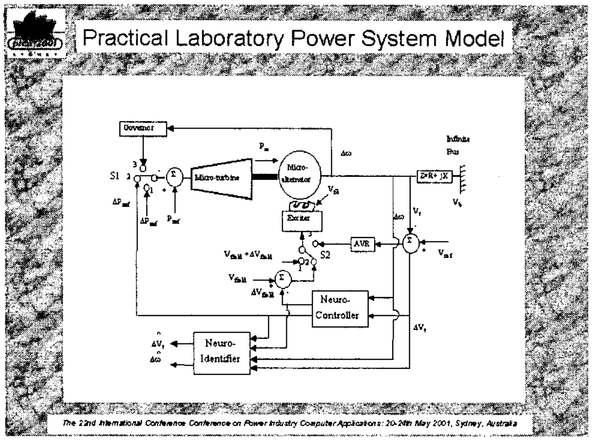

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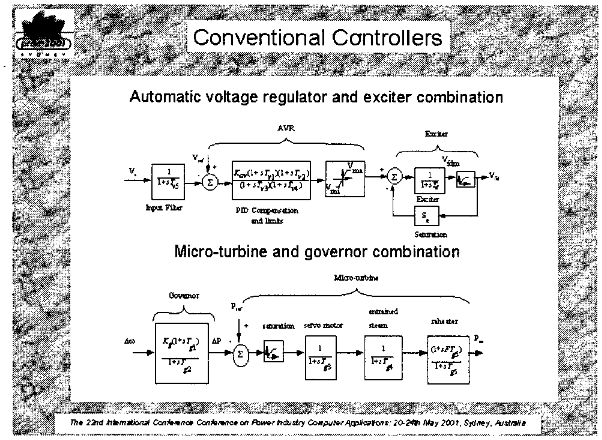

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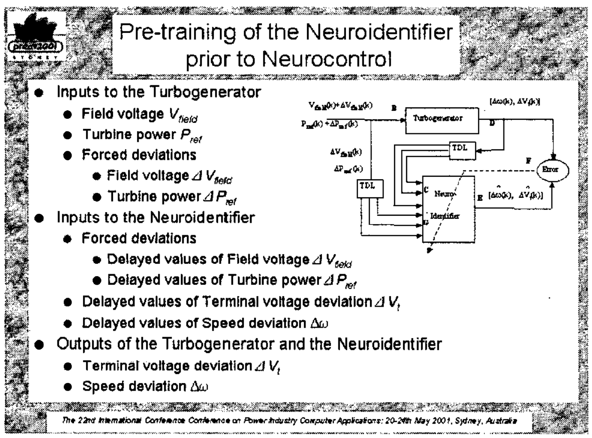

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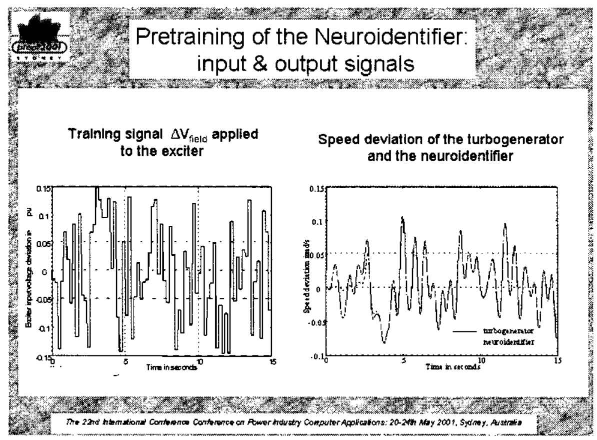

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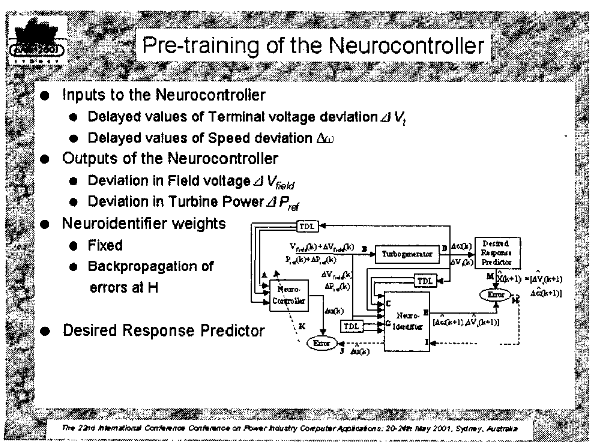

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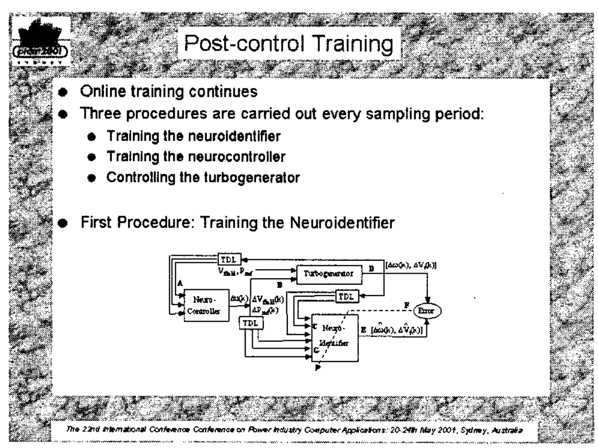

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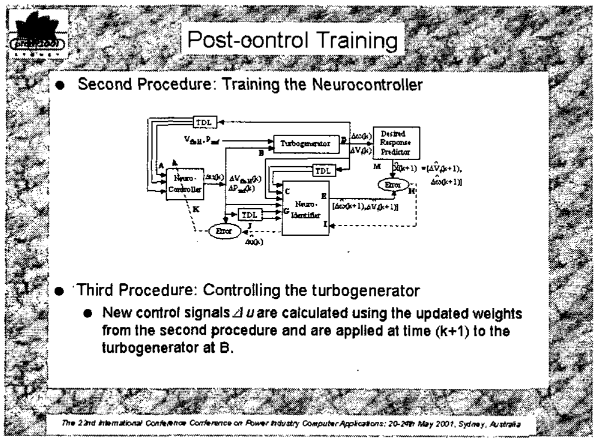

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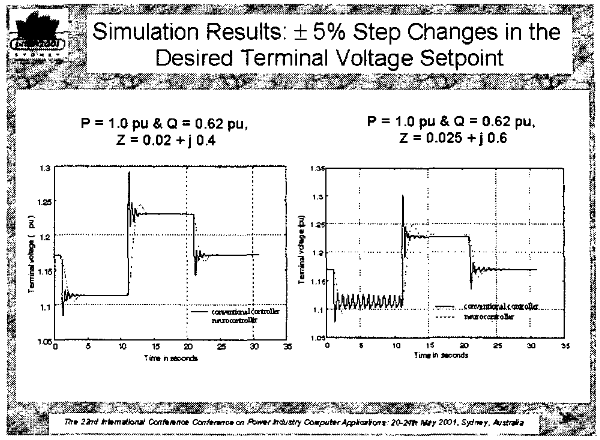

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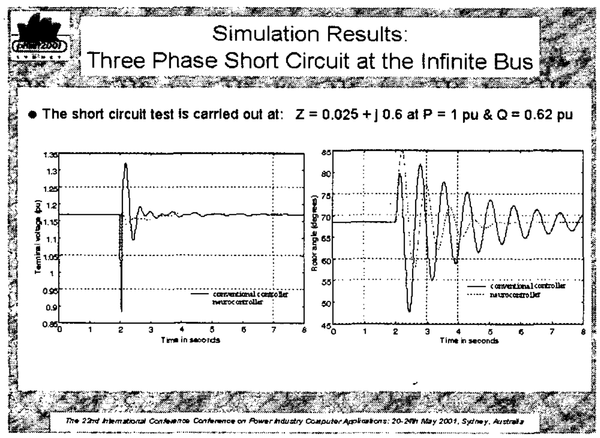

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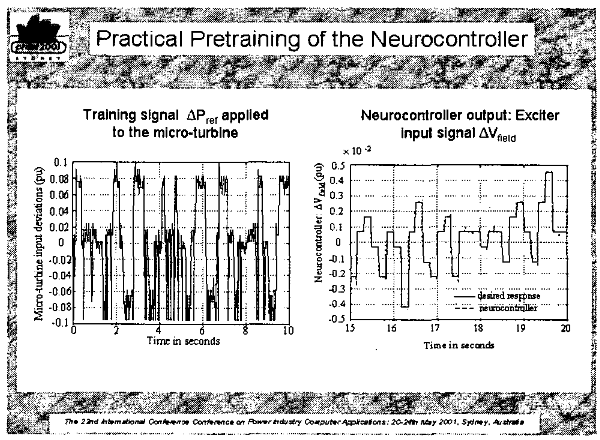

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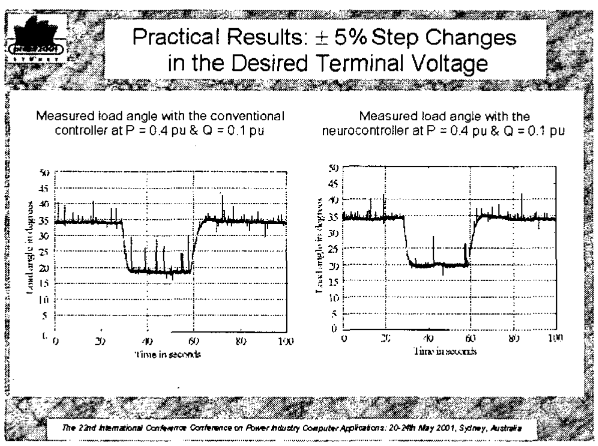

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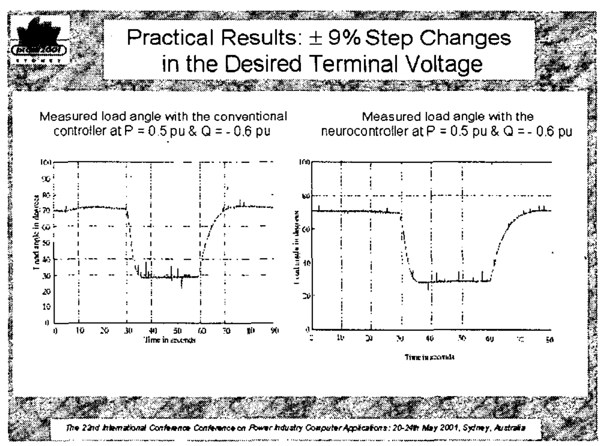

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Conclusions

- A continually online trained neurocontroller strategy has been proposed and implemented for turbogenerator excitation and turbine governor.
- The neuroidentifier and neurocontroller undergo pre-training until convergence is attained, before allowing them to control the turbogenerator. Thereafter they undergo continually online training. Hence the stability and robustness issues are not a major problem. since the neural network inputs and outputs are *deviation signals*.
- The results illustrate that not only is it possible to practically implement neuroidentifiers and neurocontrollers, but that their performance is comparable to, or better than the benchmark conventional controllers which are fine tuned for a particular operating point and system configuration.
- However, when the system conditions change, such as different power levels, the neuroidentifier correctly identifies these changes, and the neurocontroller performance therefore does not degrade, as in case of the conventional controllers.

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Conclusions

- The superior performance of the neurocontroller occurs because the *online training* never stops and *deviation signals* are used.
- Another important consideration is that the neural networks have no prior information of the turbogenerator and the grid it is connected to, need no tuning on site during commissioning, and are therefore completely self-commissioning.
- Such neurocontrollers allow power plants to be operated closer to their steady state stability limits, thus producing more electrical power per Dollar invested.
- Further studies are in progress with this neurocontroller on a three-machine power system which suffers from multi-mode oscillations, and preliminary results look encouraging.

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