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High Speed Transient Stability Program

The electric network solution method used with the increasingly popular RTDS digital TNA is based on the well known electromagnetic transients (emtp) algorithm originally developed by Dr. Hermann Dommel. Those who are familiar with the system size limitations imposed on emtp because of its detailed representation have asked the following question: How can the speed of the RTDS parallel processor be best utilized to model very large power systems?

The familiar transient stability program is one way large electric power systems could be modeled if its phasor based solution method can be efficiently loaded into the parallel processors of the RTDS. Then, the electromechanical transient stability of very large power systems could be assessed with fast solution times and if needed in real time. There is also the possibility of combining the detailed emtp solution for dc link and FACTS controllers along with the electromechanical stability solution of the total system. Controls and protections can still be tested in real time using the RTDS digital TNA and simulator, but a better representation of the total power system will be possible with both emtp and transient stability solutions running together.

The Manitoba HVDC Research Centre is working on this project in cooperation with the Electric Power Research Institute (EPRI) in Beijing. Funding assistance is being received from the Canadian International Development Agency (CIDA) under the administration of BC Hydro International.

For the stability solution, the high speed solution is developed in the "C" computer language allowing the program to be compiled on many parallel processing computers. Several network solution methods suited for use on parallel processing computers are being developed and tested.

Validation tests, using existing stability programs, have been performed using single processor workstations on a 500 bus system. Results are very encouraging. Efforts are continuing in development of detailed machine and exciter models and non-linear load models. The high speed stability program will be tested in the near future using the RTDS parallel processing computer. It is expected that it will be over one year before the software will be available for general use.

Wes Kwasnicki is the project leader and he is assisted by Alan Wang and Lawrence Arendt. Tang Yong and Qiu Qun from EPRI are presently working at the Centre as part of the development team.

High Speed Stability Development Team
Qiu Qun, Alan Wang, Wes Kwasnicki, Lawrence Arendt, Tang Yong

Project Report :
Modelling of Electric Discharge in Dielectrics

Dielectric breakdown due to impressed electric fields upon dielectrics is a naturally occurring phenomena within air gaps and within solid dielectrics. In the case of high voltage power systems, this phenomena can lead to costly equipment failure and down time. The resultant random discharge patterns cannot be modeled and simulated using standard analytical methods. Instead, stochastic fractal models which require the solution of Laplace's equation of the potential field must be employed to simulate and "grow" similar discharge structures. The process is generally such that:

1. The initial electrode, dielectric, and corona seed configurations are defined on a discrete mesh.
2. Laplace's equation for the potential field is solved for all mesh points.
3. The probabilities of all potential growth sites, related to the electric field, are evaluated.
4. One potential growth site is randomly selected and added to the corona structure.
5. Steps 2 through 4 are repeated until the corona growth is arrested, or punch-through occurs.

The system to be modeled is represented by a parallel plate capacitor, with a homogenous dielectric, using a 500×500 (or larger) discrete mesh. A pattern of the potential fields and the corona discharge is shown in Figure 1. In 1988 a HVDC wall bushing failed at Dorsey Converter station. Figure 2 shows the puncture in the shattered porcelain.

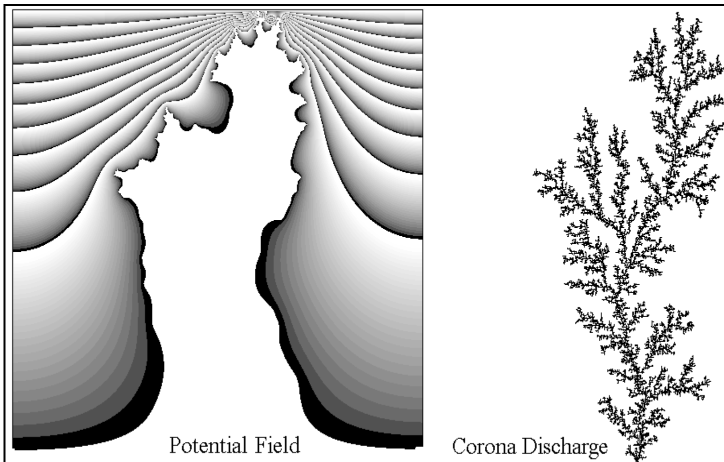

Figure 1 : Fractal Discharge Patterns

The discrete finite difference approximation of Laplace's equations for the mesh points yields about 500^2 linear equations. Obtaining the solution by direct methods is not feasible, therefore, iterative methods are employed. To speed up the convergence rate, *accelerated* point, line, or block iterative methods were implemented. Maximum convergence results when the optimal acceleration, dependent on the dominant eigenvalue of the equivalent iteration matrix, is used. The growing corona is assumed to be at zero potential, we have non-stationary Dirichlet boundaries (singularities) in the interior of the mesh, lowering the value of the

Figure 2 : Radial Puncture in Failed Bushing Porcelain

dominant eigenvalue. To attain near-optimal convergence, the non-stationary dominant eigenvalue have classically been estimated from the residual norms. An improved estimation method, using the maximum spectral radius of 8 singularity free rectangular regions has been developed. This method offers a four-fold reduction in the average residual error.

Discharge patterns were generated from sets of simulation run in which various parameters were changed. The patterns are different even though they look similar. Multifractal measures were employed to compare the similarity of discharge patterns. Results show that the multifractality is not affected by the iterative method used, but it is impacted greatly by the selection of the random generator use to model the stochastic nature of the discharge.

Project Researchers were Lawrence Arendt of the Centre and Prof. W. Kinsner from the University of Manitoba.

Project Update: Collaborative Research Condition Monitoring Of HV Breakers

The Centre is coordinating a 2 year field trial of various condition monitoring systems on a 230 kV breaker located in Manitoba Hydro's Dorsey Converter Station. On-line Condition Monitoring Technology promises to improve reliability and reduce maintenance costs by monitoring operating parameters of the breaker. Over the past several months the Centre has invited utilities and manufacturers to participate in this project. This project has attracted international attention and is scheduled to commence in October 1996.

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Multi Limb Transformer Model for PSCAD/EMTDC

Wade Enright

Wade Enright from University of Canterbury, New Zealand, is visiting Centre for four months. Wade arrived in Winnipeg in April to implement his Unified Magnetic Equivalent Circuit (UMEC) transformer model from his Ph.D. work with PSCAD/EMTDC. With the UMEC model we can easily simulate the mutual coupling between the windings of a multi-limb transformer (3 or 5 limb). It also allows a distributed representation of transformer magnetizing current, which is more accurate than lumping saturation current on one side of the transformer. The new model will be available as a standard component with PSCAD V3.

Wade will defend his thesis after his return to Canterbury in August, and begin work with the Electricity Corporation of New Zealand Ltd (ECNZ).

PSCAD VERSION 3

Visit The Centre Hospitality Suite
IEEE Summer Meeting In Denver

PSCAD-V3 alpha version will be demonstrated in Denver at the Centre's Hospitality Suite, located in the ADAMS MARKS Hotel, in conjunction with the IEEE Summer Power Meeting. Demonstrations will be given on both PC and Unix Workstations. The latest version of the Real Time Playback (RTP) system will be demonstrated.

The Hospitality Suite will be open from 5:00 to 8:00 pm Monday July 29 to Wednesday July 31. Users' comments will help in fine tuning the interface before the final release.

Centre Staff at the Manitoba Marathon

It was a warm Manitoba morning on June 16. A great day for running. Dennis Woodford and Wade Enright completed the ½ Marathon. The Centre was well represented in the Corporate Relay by the team of Craig Muller, Garth Irwin, Om Nayak, Ioni Fernando and Jodi Enright. They completed the full marathon in 4 hours and 10 minutes.

Congratulations !!

Rumors were "ALL" had a great time but it was noticed that a 'FEW" were limping slightly on Monday morning.

Good Engineering is like running a Marathon.
5% inspiration 95% sweat and effort

The Centre "Dream Team"

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