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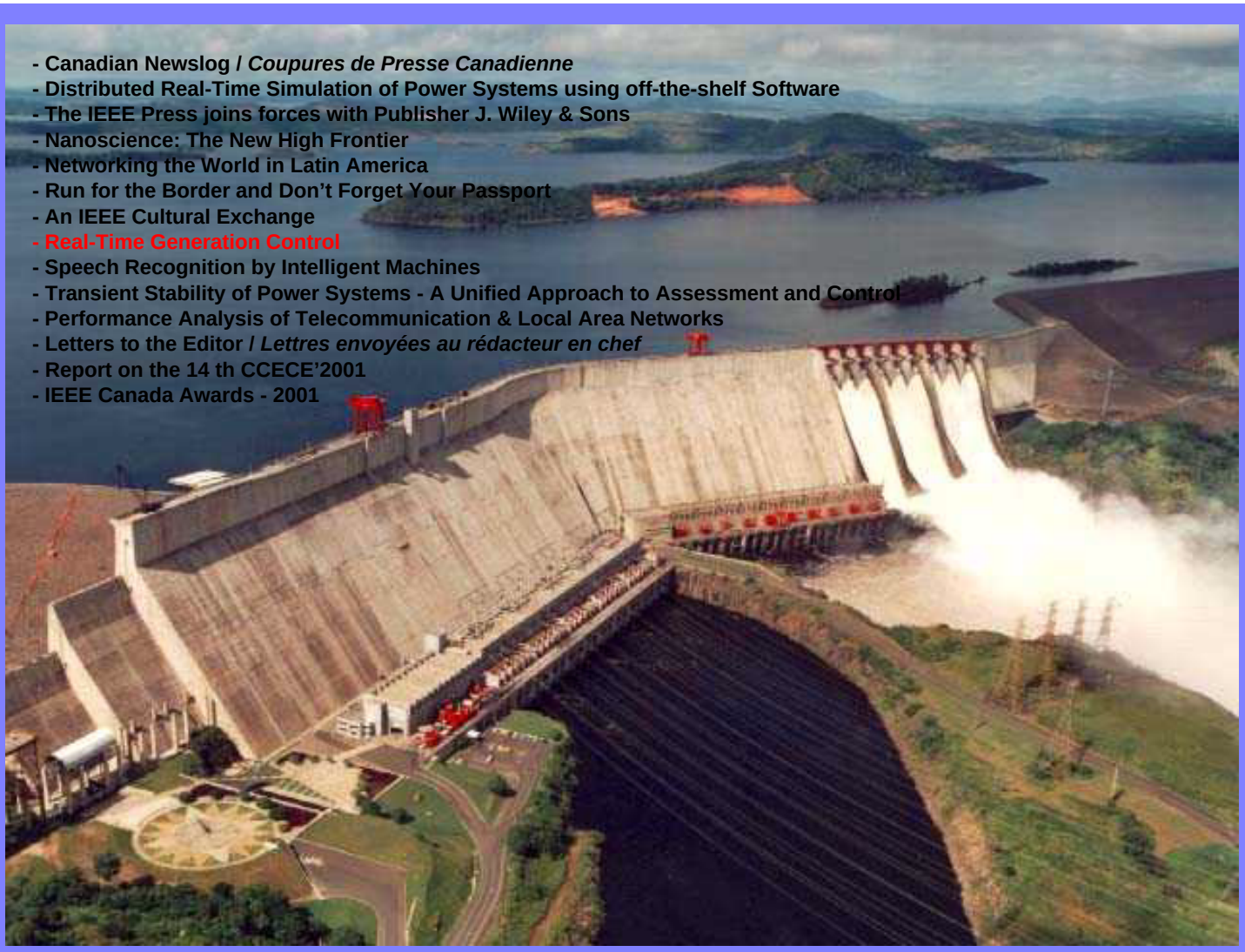

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Quelques mots du rédacteur en chef

Vijay K. Sood, Hydro-Québec, Varennes, QC

L'édition d'été de la revue canadienne de l'IEEE comprend les activités de récompense de plusieurs organisations telles le l'Académie des Ingénieurs et l'IEEE Canada. Toutes les récompenses principales remises par ces organisations à des membres de l'IEEE sont ci-jointes et je félicite tous ces membres.

Notre région a été active lors des derniers mois et l'activité principale était la réunion régionale et la conférence CCECE'2001. Un portrait général de cette conférence est brossé dans cette édition de la revue canadienne de l'IEEE.

L'article principal de SNC-Lavalin reflète l'impact d'une importante firme de génie canadienne dans le marché international. Je suis tout particulièrement intéressé par ce type de récit et j'encourage d'autres experts-conseil ainsi que les firmes de génie à nous transmettre des articles sur leurs histoires de réussite.

Les presses de l'IEEE ont uni leurs forces avec Wiley, la maison d'édition internationale; je me rejouis de ce lien. Il y aura plus d'activités avec Wiley dans la revue canadienne à l'avenir.

Au moins 10 courriels ont été reçus suite à la dernière édition de la revue canadienne. Trois courriels sont imprimés dans la section du courrier à l'éditeur. Les autres courriels étaient assez flatteurs; il n'était donc pas pertinent de les inclure pour des raisons d'espace. Cependant, j'aime recevoir de tels messages, n'arrêtez surtout pas... J'ai répondu à tous personnellemment.

Enfin, je souhaite à tous un agréable été et j'espère que vous allez tous profiter des fruits de votre labeur. Quelques exemples sont joints pour votre plaisir.

"Here are some carved melons and coconuts for cool receptions during the hot hot summer."

"Voici des melons et des noix de coco taillés pour des journées fraiches durant un été chaud chaud chaud".

Cover picture / *Photo de couverture*

The cover picture shows an aerial view of the Guri Power Plant on the Caroni River in Venezuela. The plant consists of two powerhouses, each containing 10 generating units. The total capacity of the 20 generating units is 10,000 MW. There are 3 high-voltage switchyards at 800 kV, 400 kV and 230 kV voltage levels. The Guri spillway includes 3 groups of gates and each group has 3 gates pertaining to the same water chute.

A few words from the Managing Editor

This summer issue of the Canadian Review includes awards activities from various organisations such as the Academy of Engineers and IEEE Canada. All the major awards provided by these organisations to IEEE members are included here and I offer my congratulations to these members.

Our Region has been active in the past few months and the major activity was the regional meeting and the CCECE 2001 Conference. An overview of this conference is presented in this issue.

The lead paper from SNC-Lavalin reflects the impact of a major Canadian engineering firm in the international market. I am particularly interested in such stories and encourage other consultants and engineering firms to come forward with articles on their success stories.

IEEE Press has joined forces with Wiley, the international book publisher, and I welcome this liason. There will be more activities with Wiley and the CR in days to come.

At least 10 emails resulted from the previous issue no. 37 of the IEEE Canadian Review. Three such letters are printed in the section on letters to the editor. The other emails were very complementary about the CR, and I felt it unnecessary to include them for reasons of brevity; however, I do like receiving such emails ... so please don't stop. I have responded personally to all concerned.

Finally, I wish you all an enjoyable summer and hope you taste the fruits of your labours. Some samples are attached here for your delight.

Contents / *Sommaire*

Newslog Editor

Rédacteur des coupures de Presse

Alexandre Abecassis is a patent agent trainee at Swabey Ogilvy Renault, patent and trademark agents in Montreal.

Alexandre Abecassis travaille à Montréal chez Swabey Ogilvy Renault, agents de brevets et de marques de commerce, comme agent de brevets en formation.

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Veuillez faire parvenir les coupures de presse proposées par e-mail à alexandre.abecassis@ieee.org

VANCOUVER, BC, Jun. 28. 360networks announced that the company and several of its operating subsidiaries have filed for protection under the Companies' Creditors Arrangement Act in the Supreme Court of British Columbia. The company and the subsidiaries covered by the filings currently have approximately $155 million of unrestricted cash, cash equivalents, short-term investments and marketable securities on hand. 360networks expects to use these funds to maintain service to existing customers in Canada and the United States, and to complete key segments of its North American network.

HALIFAX, NS, Jun. 27. Knowledge House Inc. unveiled its web-based high school program. This is the first web-based high school program in the world. The program will offer a multi-disciplinary, collaborative environment for students all over the world using the Internet. The school named "Wellspring school" has begun to accept applications for the session that will begin in the Fall of 2001.

PALO ALTO, CA, Jun 25. Sun Microsystems, Inc. has selected the University of Alberta as its first-ever Sun Center of Excellence for E-learning. The University of Alberta offers the largest online learning facility with more than 1000 courses offered in January 2000. 100,000 enrolments are done using WebCT which works under a Solaris environment.

MONTRÉAL, QC, le 20 juin. L'École Polytechnique et l'Université de Montréal sont récipiendaires d'un don de 1 million de dollars. Ce don permettra la création d'un programme de bourses et d'un laboratoire. Ce don a été remis par CAE et rend hommage à M. R. Fraser Elliott, ancien président du conseil de la compagnie.

CALGARY, AB, Jun. 19. A new program has been launched today by Bell Canada to provide telecommunication tools for Canada's top amateur athletes and Olympic hopefuls in order to keep in touch with their coaches and relatives during a training or a competition. The new program comprises the offer of a cell phone as well as airtime credit. The program is supported by Athletes Can, the Canadian Olympic Association and Samsung Telecommunications America.

MONTRÉAL, QC, le 17 juin. Le Gala des Octas, organisé par la Fédération de l'informatique du Québec et qui récompense des entreprises, des organismes ou des individus s'étant illustrés dans les technologies de l'information a vu la consécration de la compagnie Nurun, récipiendaire d'un Octa de l'excellence pour la réalisation d'un site de commerce électronique.

LEESBURG, VA, Jun. 6. Data communications are now available in the satellite constellation Iridium. The service is available everywhere on Earth. Iridium's dial-up data capability will offer a connectivity of 2.4Kbps to a corporate data network. A direct Internet connection will be available to a private user at a bandwidth of 10Kbps.

TORONTO, ON, May 31. Despite the slowdown in the economy and in the industry, more than 50% of Canadians think that the IT sector is a major contributor to the Canadian industry. More than 78% think that the IT sector is more important than other sectors to the economy. The study was conducted by IDC Canada on behalf of the Information Technology Association of Canada (ITAC).

MARKHAM, ON, May. 29. ATI made public its new TRUFORM(TM) technology. The technology is based on the use of N-patches, which are high order surfaces composed of curves rather than triangles. The technology is compatible with current software graphics libraries and enables a user to have an enhanced visual rendering of 3D surfaces.

MONTRÉAL, QC, May. 25. Dr. Marc Garneau, vice president of the Canadian Space Agency (CSA) and former astronaut announced that the CSA will expand its space exploration over the next years. The major focus will be Mars. A budget of 500M$ will be necessary for the mission. The project will necessitate a collaboration with another space agency.

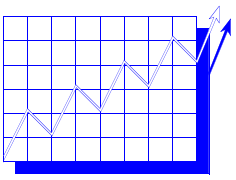
TORONTO, ON, le 22 mai. Une baisse de 3% du taux de piratage informatique a été constatée par l'Alliance canadienne contre le vol de logiciels (ACCVL); ce qui est un changement de tendance après quatre ans d'augmentation. Plus d'une application logicielle d'affaire sur trois est piratée au Canada. L'Amérique du Nord reste toutefois la région la moins touchée du monde en terme de piratage. Le piratage porte préjudice à hauteur de 457 millions de dollars au Canada.

TORONTO, ON, Apr. 25. HealthSat Networks Inc., which provides e-learning content over Canada in the health domain, supports the Ontario government's commitment to establish a "made in northern Ontario" medical school that will enable medical professionals to be trained using e-learning content. The medical school will comprise continuing education programs for doctors and nurses.

OTTAWA, ON, Apr. 10. An Internet satellite-delivered access service will be available to Northern Canada. This new service will provide users affordable solutions in remote locations. This service will be delivered by RAMTelecom and will use Telesat Canada resources. The user will choose between one-way and two-way connections to the satellite.

MISSISSAUGA, ON, Apr.3. Microsoft Corp unveils actions that are taken against counterfeiters by enforcement agencies. The actions will target "online" counterfeiters that offer counterfeit products on web sites or auction web sites. An internet scanning tool is used to discover illegal online offering, 24 hours a day, 7 days a week.

TORONTO, ON, Mar. 20. AOL Canada, Inc and Telus mobility announced that AOL Mobile (^{TM}) services will be available to clients who own dot com ready phones on all Telus digital networks.



Distributed Real-time Simulation of Power Systems Using Off-the-shelf Software

by *Nicolas Léchevin, Camille Alain Rabbath and Paul Baracos*
Opal-RT Technologies Inc., Montreal, QC

Abstract

This paper presents an innovative approach to the problem of rapid simulation of complex power systems. The popular commercial software package, Simulink, when combined with Hydro-Quebec's Power System Blockset (PSB) and Opal-RT's ARTEMIS and RT-LAB provide an off-the-shelf solution for real-time and accelerated non-real-time simulation. Each software product plays a role in the solution. Simulink provides the graphic programming environment, the PSB provides the device library, ARTEMIS corrects for numeric instabilities and imprecision while accelerating the simulation and RT-LAB manages real-time performance and I/O while allowing further acceleration by way of parallel processing.

Sommaire

Cet article propose une nouvelle approche pour la simulation rapide de systèmes électriques complexes. En combinant l'utilisation de Simulink avec le Power System Blockset d'Hydro-Québec, et avec ARTEMIS et RT-LAB d'Opal-RT Technologies, on obtient une solution simple et efficace pour la simulation en temps réel et pour l'accélération de simulations de systèmes électromécaniques. D'une part, Simulink sert d'environnement graphique et le Power System Blockset nous donne une librairie de base. D'autre part, ARTEMIS fournit une méthode d'intégration numerique à pas fixe précise et stable, tout en accélérant la simulation, et RT-LAB coordonne les performances de systèmes distribués qui s'exécutent en parallèle, en temps réel, et des communications entre processeurs.

1.0 Introduction

In control-system test benching, hardware-in-the-loop, rapid control prototyping and other time-critical power-system simulation applications, engineers must use fixed-time-step simulation (as opposed to variable-time-step) to meet hard-real-time constraints. A hard-real-time simulation is one where each simulation step must be completed within a tight deadline, usually measured in microseconds. Even in non-real-time simulation, fixed-time-step simulation may offer a significant speed advantage over variable-time-step simulation. However, choice of a simulation step size is critical to ensure stability of a complex dynamic system.

In the real world, engineers also face real-life constraints: limited budgets and tight deadlines. To do this effectively, they would prefer to use familiar and well debugged software products such as the Mathworks' block-diagram language, Simulink, and its Power System Blockset (PSB) rather than writing their own code. Until recently this has not been possible because these popular tools, although very powerful, were not generally usable for real-time application. To make Simulink and the PSB usable for real-time simulation and to accelerate simulation, Opal-RT Technologies Inc. has developed performance-enhancing software, available commercially as RT-LAB and ARTEMIS.

Power systems constitute a class of stiff systems that are particularly hard to simulate in real-time due to the presence of algebraic and hard nonlinearities such as switching converters and because their eigenvalues vary widely. In order to obtain precise numerical responses, variable-step solvers such as MATLAB's ODE15s (Numerical Differentiation Formula) may be used when long simulation times are tolerable. The built-in fixed-step size integration methods such as Trapezoidal (as used in EMTP) or Tustin (as used in PSB) give faster simulations but are not free from numerical oscillations. The patent-pending ARTEMIS algorithms, based on a suitable order Padé approximation of matrix exponentials, provide L-stable methods [1,2] that are oscillation-free for a wide range of step sizes and are therefore efficient for the fast simulation of power systems [3,4]. This paper illustrates these advantages with reference to a *de facto* standard bench-mark, Kundur's power system.

This power system (Figure 1) is often used as an example in the literature for inter-area oscillation analysis [5], design and test of stabilizers [6] and modeling for simulation purposes [7]. This system is symmetric and each machine is driven by a hydraulic turbine with governor, and an exciter with power system stabilizer [8].

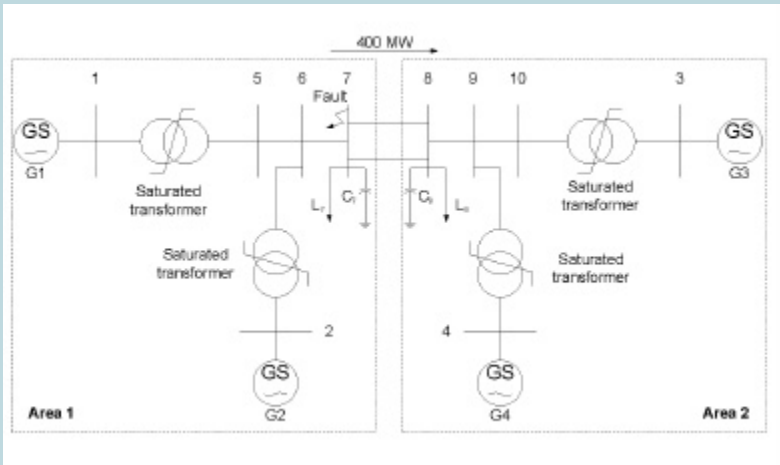


Figure 1: Kundur's Power System.

Figure 2 shows this benchmark power system represented as a PSB diagram in Simulink. Area 2 is shown as a mask and the ARTEMIS block is shown in the lower left-hand corner. From a user point of view, ARTEMIS is easy to use: simply place the ARTEMIS block into your diagram and its advanced state-space solver takes over from the built-in solver.

2.0 Computing Efficiency

A simulation is executed on [0, 2s] with a short-circuit on [0.5s, 0.6s] at the bus 2 between load 7 and the PI line. Table 2 displays the time performance of the simulation versus the integration method and the simulation mode. The first three rows are for Simulink's usual mode of simulation. The last two rows are for compiled simulations under RT-LAB platform with respectively one and two computation nodes. In the last case, the power system is divided into two symmetric areas of equal computational complexity.

The following setup is used:

- **Software:** MATLAB R12, PSB v.2, ARTEMIS v.1.2
- **Hardware:** Pentium II; 550 MHz; 128 MB RAM;
- **Architecture:** one CPU and two CPUs (shared memory).

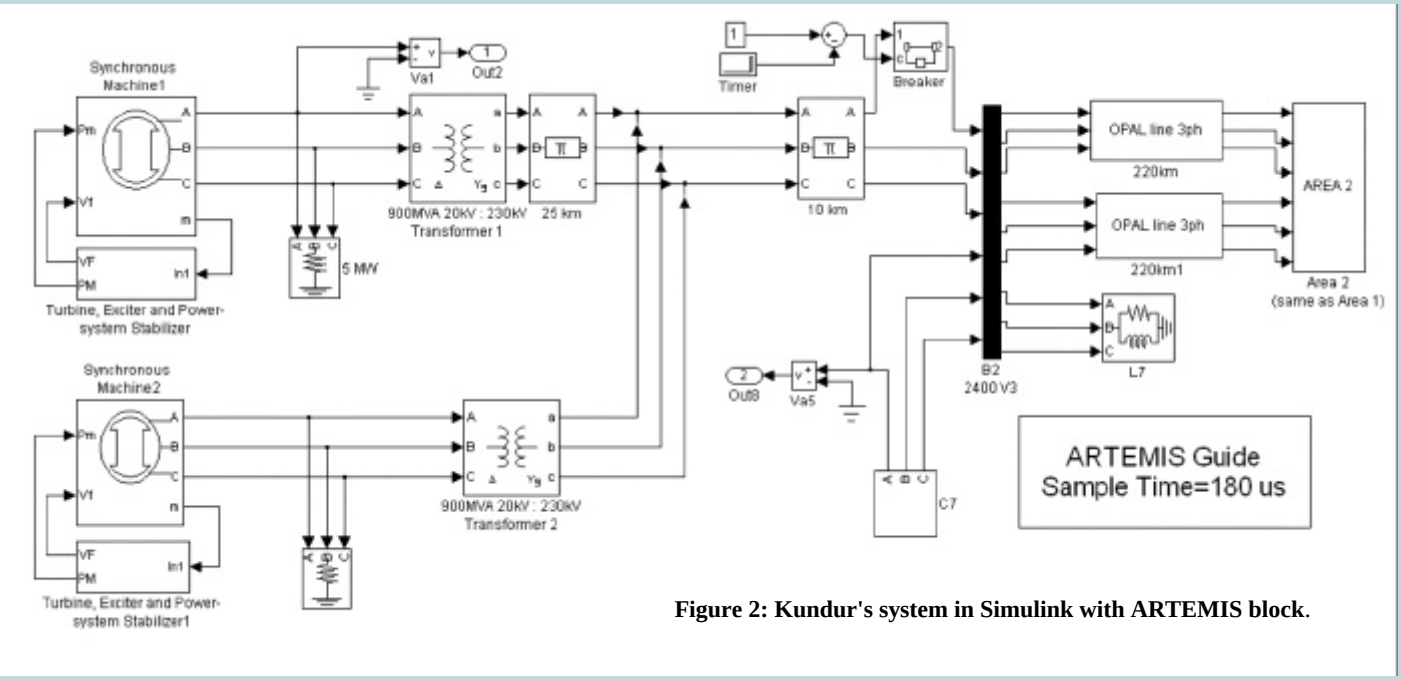


Figure 2: Kundur's system in Simulink with ARTEMIS block.

Table 1: Simulation time with and without ARTEMIS

Simulation mode	Dynamic system solver Ts: stability limit	Execution time per time step (ms)	Total execution time (s) on [0,2s]	Speed-up vs. variable step	Speed-up vs. Tustin
Simulink-mode	Variable step: ode15s (PSBv2)	-	46 min.	1	-
	Tustin (PSBv2.): Ts=130µs	2.2	34	81	1
	ARTEMIS: Art3hd Ts=210µs	1.9	18	153	1.8
Compiled mode under RT-LAB NT Platform	ARTEMIS: Art3hd Ts=210µs 1 CPU	0.15	1.5	1840	22
	ARTEMIS: Art3hd Ts=210µs 2 CPUs	0.1	1	2760	34

As seen in Table 1, ARTEMIS fixed-step-size-integration methods can substantially improve the simulation execution time. Furthermore, since the algorithm is not iterative, each simulation step takes a fixed computation time, which is required to meet the hard real-time constraint.

3.0 Simulation stability

In this section, stability and oscillation damping properties of ARTEMIS methods are shown and compared with Tustin of PSB v.2. Figure 3 shows the terminal voltage of machine 1, the current of the transformer's second winding as well as its magnetizing current are displayed so as to show the efficiency of the proposed solvers.

In Figure 4, system responses of machine 1's terminal voltage and current of transformer's secondary winding are displayed in order to show ARTEMIS improvement in terms of stability and numerical oscillation damping. This signal is more meaningful than line voltage near the fault (bus 7) because of the interaction of the machine and the remaining network. Effects of the modeling method are more obvious at this location. Note that Euler's method (ODE1) of Simulink's solver is used for all

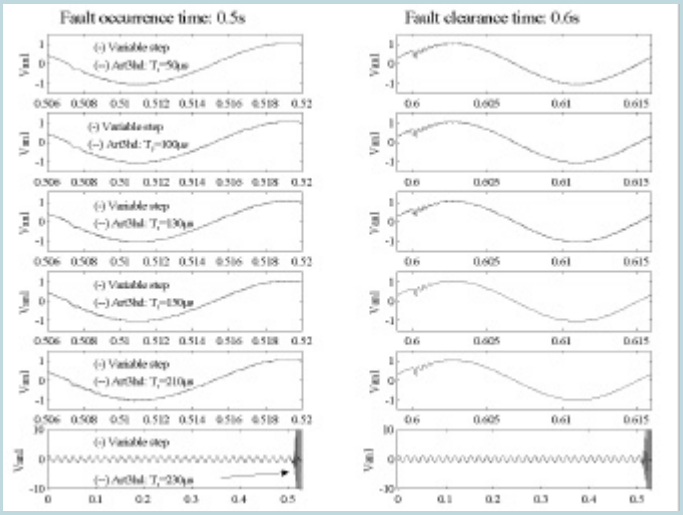


Figure 3: Illustration of Art3hd (ARTEMIS) stability limit.

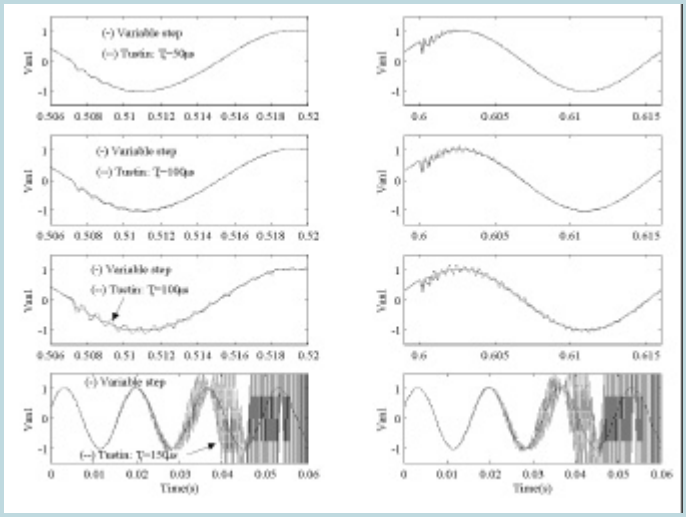


Figure 4: Illustration of Tustin (PSB) stability limit.

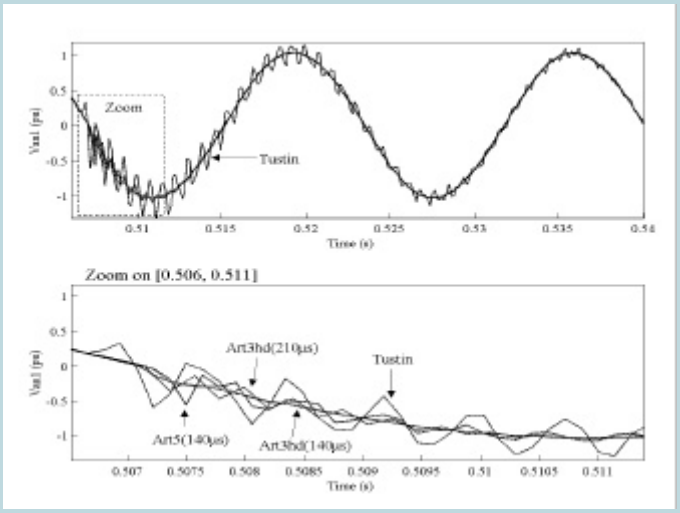


Figure 5: Terminal voltage of machine 1 at fault occurrence time: comparison of integration methods.

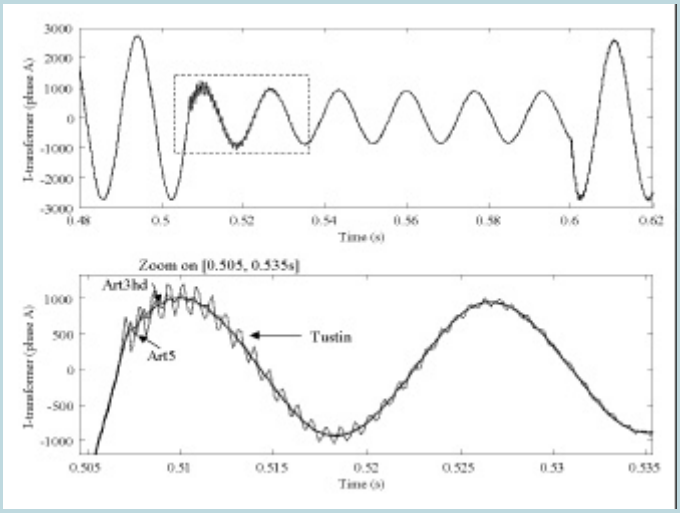


Figure 7: Current at the transformer's secondary winding (machine 1).

fixed-step integration methods under consideration besides ARTEMIS. ODE1 allows solving every continuous systems, i.e. turbines, stabilizers, exciters and machines which, in the last case, are discretized with the forward Euler method only when PSB v.2 is used. In this way, the use of ODE1 avoids compatibility problems such as the machine initialization and is more suited for a comparative study.

It is clear from Figures 3 and 4, that Art3hd of ARTEMIS can simulate the power system with a larger sample time. This constitutes an interesting property for real-time simulation purposes. Though not shown, ARTEMIS'Art5 present intermediary results between Tustin and Art3hd with a loss of stability at Ts=160 microseconds.

Figures 5 and 6 show the terminal voltage of machine 1 at fault occurrence time allowing a comparison of integration methods. Clearly, the ARTEMIS algorithm yields superior numerical results.

In order to evaluate the precision of the different fixed-step size methods, the time-averaged quadratic error of the machine 1's terminal voltage (1pu of amplitude) is calculated on [0 2s] as shown in Equation (1).

$$\varepsilon(t) = \sqrt{\frac{1}{t}\int_0^t \left(x_{fixed-step}(\tau) - x_{variable-step}(\tau)\right)^2 d\tau} \qquad (1)$$

Error in terminal voltage is shown in Figure 8. High values of error due to a small time t are not displayed.

Art5 method exhibits smaller error (Figure 8) than Tustin's. Art3h's error is less important due to its good damping abilities during the transient but tends to be less precise than the other two methods in steady state. Note that an increase of time-sample (Ts = 210µs) or Art3hd close to its stability limit still gives much better results (smaller error increase) than with Tustin (Ts = 140µs) during the transient. The same remark goes with Art5 with a sample-time of 150µs.

Henceforth, the possibility of automatic selection of the fixed-step size integration method is considered in the near future in order to fully exploit the benefits of each integration method of ARTEMIS.

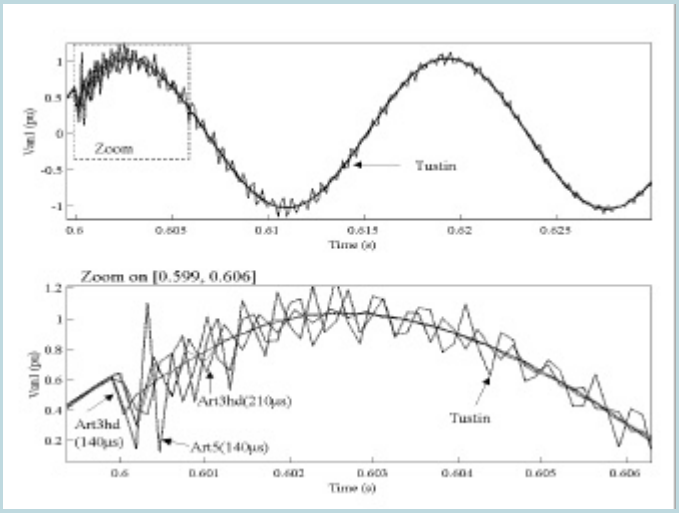


Figure 6: Terminal voltage of machine 1 at fault clearing time: comparison of integration methods.

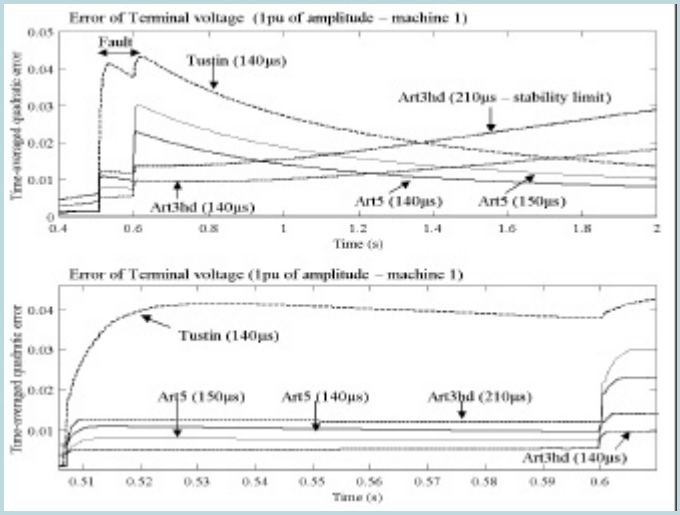


Figure 8: Time-averaged quadratic error of simulation results with Tustin and ARTEMIS versus variable step solver.

For long-term stability Art3hd's response deteriorates versus Tustin's and Art5's, which are quite similar but slightly out of phase with respect to the variable-step integration method. However, a small delay subsists with Art5 as compared to Tustin, which may result in the accumulation of machine modeling error. Continuous models used for ARTEMIS simulation are integrated by a fixed-step size method that may differ from the forward Euler machine model of PSB v2. However, for smaller networks, ARTEMIS results are superior to those obtained with Tustin's method [3]. See [4] for a comparative study of ARTEMIS solver versus Tustin.

The latter consideration combined to the desire to use multi-rate simulation motivate us to develop appropriate voltage-behind-reactance machine model, which is expected to give superior results than those obtained with the whole machine modeled as a current source.

4.0 Conclusion

The off-the-shelf solution for distributed real-time simulation, consisting of Simulink, Power System Blockset, ARTEMIS and RT-LAB, provides better numeric stability, superior damping of oscillations and improved precision compared with those using solely Simulink and the Power System Blockset. The proposed solution is suitable for real-time simulation, hardware-in-the-loop, controller test benches and rapid control prototyping. It can also be used to accelerate simulation for analysis and design of circuits and controllers especially when simulations are run in parallel.

5.0 References

[1]. E.Hairer, S.P. Norsett, G. Wanner, "Solving Ordinary Differential Equations I: Non-stiff Problems," 2nd edition, Springer-Verlag, 1993.

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About the authors

Nicolas Léchevin received the B.Eng. degree from ESAIGELEC in St. Nazaire, France, and his M.Sc. and Ph.D. degrees from the University of Québec, Trois-Rivières, Canada. He is now working for Opal-RT Technologies Inc. as a power-system simulation specialist. His research interests include control, estimation and numerical simulation applied to robotics and electric power systems.

Camille A. Rabbath obtained his Ph.D. degree from McGill University, Montreal, Canada in 1999. Since then he has been an adjunct professor at McGill University and a consultant in control systems for Opal-RT Technologies, Inc. His research interests include digital control of engines, sampled-data control systems analysis and design, distributed simulations, and multi-rate modeling, simulation and control.

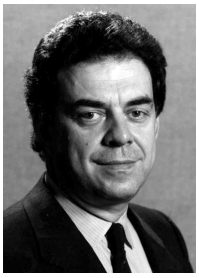
Paul Baracos, Ph.D., has been involved in simulation and control systems since 1976. He has degrees in Physics, Systems Design and Mechanical Engineering and twenty years experience as a professional engineer. He joined Opal-RT as Director of Products in 2000.

Appointment

Anastasios (Tas) Venetsanopoulos named Dean of the Faculty of Applied Science and Engineering at UofT

The Academic Board of the University of Toronto's (UofT) approved the appointment of Anastasios (Tas) Venetsanopoulos to a five-year term as the Faculty's 12th Dean, effective July 1, 2001. Venetsanopoulos succeeded Michael E. Charles, who concluded his eight-year term as Dean on June 30.

Venetsanopoulos received his Diploma in Engineering degree from the National Technical University of Athens, Greece, followed by M.S., M.Phil. and Ph.D. degrees in Electrical Engineering from Yale University. He joined the Department of Electrical and Computer Engineering at UofT in 1968, and has served as Associate Chair: Graduate Studies and Acting Chair of the Department. In July 1999, he became the inaugural Chairholder of the Bell Canada Chair in Multimedia.



A leading researcher in multimedia systems, digital signal/image processing and digital communications, Venetsanopoulos currently holds research grants from the Natural Sciences and Engineering Research Council (NSERC) and the Province of Ontario Research Centre of Excellence on Communications and Information Technology (CITO). He has served as a lecturer in 138 short courses to industry and continuing education programs. He is a contributor to 29 books and has published over 650 papers on digital signal and image processing, and digital communications.

He has served on numerous boards, councils, and technical conference committees of the IEEE. He has also served as President of the Canadian Society for Electrical Engineering and Vice President of the Engineering Institute of Canada (EIC) and is a Fellow of the IEEE and the EIC.

The IEEE Press joins forces with publisher J. Wiley & Sons

The IEEE Press has joined forces with worldwide publisher John Wiley & Sons to give increased market reach at reduced costs. The IEEE also gains the prestige and recognition of an association with a global publisher such as Wiley, while Wiley adds to its portfolio immediately 180 titles from the world's premier technical professional society.

The goals of this partnership are:

- to preserve the IEEE Press identity within a co-branded imprint, expand the marketing and sales reach,
- secure a home at the IEEE for book authors,
- retain volunteer oversight and peer review participation, and
- reduce program costs.

The IEEE will maintain contacts with its authors, solicit new proposals, develop manuscripts and assist in the marketing process as a "paperless publisher capable of delivering in multiple formats", according to Ken Moore, director, IEEE Books and Information Services.

Why is the IEEE entering this partnership?

According to Anthony Durniak, staff executive of IEEE Publications, it is due to changes in the publishing business. "Since it began publishing books 30 years ago, the IEEE has seen the book market change dramatically," he said. "Working with Wiley gives us access to its impressive worldwide marketing and sales organization, which will help us more effectively serve IEEE members and the engineering community at large."

"We feel that Wiley, like the IEEE, has a strong commitment to electronic publishing, and that Wiley's e-book program will accommodate IEEE Press books, enabling us to publish our author's works in multiple formats," said Moore. "We could have undertaken this on our own, but we now have the benefit of partnership with commercial publisher."

IEEE members will continue to receive the 15 percent discount for IEEE Press books preserved under this agreement and extended to those Wiley books included in imprint.

James Tien, Vice-president, IEEE Publications, Products & Services, said the agreement will benefit both parties. "We see this partnership as a win-win situation," he said. "Wiley gets access to our world-renowned authors and reviewers and we get access to their formidable infrastructure in publication, marketing and sales."

Founded in 1807, John Wiley & sons, Inc., is a global publisher of print and electronic products, specializing in scientific, technical and medical books and journals; professional and consumer books and subscription services; and textbooks and educational materials for undergraduate and graduate students. They have publishing marketing and distribution centers in the United States, Canada, Europe, Asia and Australia.

As part of the agreement, Wiley will produce, manufacture, market, sell and distribute titles exclusively, administer author/editor royalties and contribute titles to be marketed through imprint. They will publish at least 30 new titles a year, initially for four years. New titles, which will carry both Wiley and IEEE logos, will begin to appear later this year.

An alliance with IEEE Press will immediately benefit Wiley's current offerings by adding 180 IEEE titles, Moore said. Wiley will gain impact in its already established lines, such as communications, or areas with potential for new readership, such as power engineering.

According to Moore, unions between commercial book publishers and not-for-profits have become common in recent years as professional societies seek the economies of scale that are available among the larger publishers. For their part, the publishers are eager to cultivate new markets for customers and authors. "There is also the indirect benefit in the prestige of being affiliated with a recognized professional society," Moore said.

Janet Bailey, executive publisher, scientific technical and medical publishing for Wiley, also is optimistic about the future. "By building on the strengths of each of the organizations, the alliance will enable us to better meet the information needs of electrical and electronics engineers."

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Reprinted from the Institute, April 2000, Vol. 25, No.4.

(see also the announcement on the back page of this issue).

Student and GOLD Leaders Workshops

Calgary, Alberta

September 21-23, 2001

Student Branch Leaders and GOLD Leaders are invited to a set of workshops in Calgary in September of this year. Funding has been received from the **IEEE Canada** Board of Governors as well as the **IEEE Canada Foundation**. This series of workshops will aim at helping student branch leaders and GOLD leaders to get organized, to show them sources of funding, and resources available to them. There will be two separate workshops: one for the students and one for the young professionals. However, participants from both workshops will have ample opportunities to network and get to know each other during coffee breaks, meals and a joint session to introduce the GOLD program to the students.

Any student interested in this workshop should contact:

Dominic Rivard, Student Activities Committee Chair for IEEE Canada at d.rivard@ieee.org.

Any young professionals interested in starting up a GOLD group in their section, and participating in this workshop should contact:

Ivana Vujosevic, GOLD Chair for IEEE Canada at ivanav@ieee.org

or

Slawo Wesolkowski, the GOLD Workshop facilitator and Past GOLD Chair for IEEE Canada and 2001 Chair for the IEEE GOLD Program at s.wesolkowski@ieee.org

Nanoscience: The New High Frontier

Edited by Dr. Peter A. Hackett, Vice-President, Research, National Research Council, Ottawa, ON

Abstract

Exploring the properties of matter at the atomic and molecular scale is opening a new era for science and technology. The article presents research areas that are of particular interest to scientists today and discusses the potential technology applications that may be implemented based on the discoveries. Application areas include polymer composites, advanced coatings and catalysts, molecular computing, and biological systems. There is a tremendous opportunity for Canadians to benefit from nanotechnology but seizing the opportunity requires that we develop a national strategy and make co-ordinated investments in niche areas that exploit particular Canadian strengths.

Sommaire

L'exploration des propriétés de la matière à l'échelle atomique et moléculaire marque une nouvelle ère pour la science et la technologie. Cet article souligne les domaines de recherche qui sont les plus intéressants pour les scientifiques et discute des applications technologiques possibles provenant des découvertes dans ce domaine. Les domaines d'application comprennent les polymères composites, les matériaux et catalyseurs avancés, l'informatique moléculaire, et les systèmes biologiques moléculaires. Il existe présentement une immense opportunité pour le Canada dans le domaine de la nanotechnologie. Cependant, pour pouvoir en faire partie il est impératif qu'une stratégie nationale soit développée et que le pays se prépare à investir dans les crénaux concernés pour bénéficier des compétences canadiennes.

1.0 Introduction

Canadians have grown used to amazing progress in such established fields as computers and biotechnology. Now "nanoscience", a new kid on the block, may revolutionize many other sciences, technologies and industries.

Nanotechnology's subject is the extremely small. It gets its name from a unit of measurement, the nanometre-a billionth of a metre, the size of a molecule and only ten times bigger than a hydrogen atom. But the new science doesn't stop with understanding nature on these scales. Its spinning off an engineering arm called "nanotechnology", which can manufacture structures and devices on the atomic scale.

Interesting enough, sure. But how could this matter to anyone not directly involved with it? Here is Dr. Neal Lane, Chief Advisor on Science and Technology to the former US President: "If I was asked for an area of science and engineering that would produce the breakthroughs of tomorrow, I would point to nanoscale science. It is the high frontier of the 21st century R&D [1]."

Nanoscience deciphers, and nanotechnology applies, the amazing properties that materials exhibit at the tiny scales of the molecule or atom. At that level, materials can display odd and counter-intuitive behavior. Its a world where the impossible is suddenly routine.

In a sense, all modern science is nanoscience. According to Dr. Tom Jackman, Director of the National Research Council's Institute for Microstructural Sciences, a scientist always wants to know more about nature. "Deepening our understanding", he says, "means getting down to smaller and smaller scales. And once we understand, we can also implement." Nanoscience leads directly to nanotechnology - which is nothing less than engineering on the atomic scale.

Scientists permanent quest for higher, faster, farther and especially smaller has led to modern nanoscience through the convergence of three factors:

- First, technology has supplied new instruments, such as the scanning tunnelling microscope, that let researchers track and manipulate things as small as single atoms.
- Second, recent advances in information technology let scientists construct computer-based models to visualize things too small to see directly, that otherwise are too strange to understand. One big multinational firm has developed technology that lets a systems designer "walk through" structures smaller than a microchip, seeing them as if the scientist were a few nanometres tall.
- The third enabling field of nanoscience is metrology, the science of measurement. Size, shape, mass, voltage, current and other attributes must be found in every experiment. Nanoscience poses a special challenge to metrology, for all its quantities are vanishingly small.

International or SI standards, whether of length, mass, time, or other basic properties, are administered by *Le bureau international des poids et mesures* in Paris, France. Each nation that uses SI units maintains a national laboratory that conducts R&D in ultra-fine measurement. The NR's Institute for National Measurement Standards in Ottawa has this role in Canada (Figure 1).

Consider length. The metre was defined in 1799 as one ten-millionth of the great-circle distance from the North Pole to the Earth's equator. It was redefined in 1889 as the length of a rod of precious-metal alloy, measurable to a micrometre (0.000 001 m) and kept in a Parisian vault. As metrology achieved sub-micrometre measurements, the metre was again redefined in 1960 as a certain number of wavelengths of visible light from energetic krypton atoms. Today, with the advent of lasers as more stable light sources, the metre's definition is based on Einstein's absolute: the speed of light in a vacuum. Now length metrology to tens

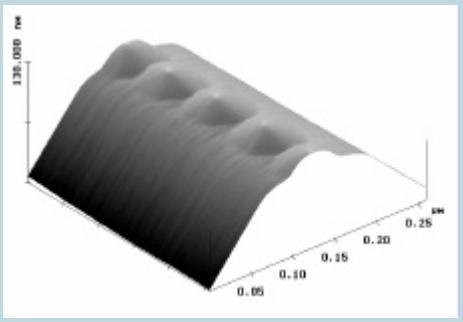

Figure 1: Atomic force micrograph showing 20 nm high self-assembled quantum dots of InAs on an InP template (NRC Institute for Microstructural Sciences).

of nanometres is routine at most national labs, and nanometre measurement is common.

An especially hot area within nanoscience is the emerging field of molecular computing. Today's C-MOS computer chips are based on silicon. Experts believe this type of chip will reach its functional limits very soon. To replace it, researchers are experimenting with nanoscale devices that require only a few electrons' difference to "flop" - the basic action by which computers processes data. If quantum-computing devices [2] can be made to flop in reliable ways and can also be mass produced, they will process data at rates that make today's 1-GHz clock-speeds seem like a crawl. Commercial prototypes of a quantum computer, says Dr. Stan Williams of Hewlett-Packard Corporation, may

be available within five years. Conveniently, this will be just as today's conventional micro-circuits hit the end of their capacity.

The benefits of nanoscience and nanotechnology extend beyond computing materials, to materials in general. Scientists at NRC's Industrial Materials Institute in Quebec have improved the structural properties of plastics by 50% through the addition of nano-sized particles of clay. Worldwide market estimates for these polymeric nanocomposites by 2009 are in the region of four to five billion dollars per year. This nano-R&D is part of an NRC program to change the properties of materials by introducing tiny particles into various substrates [3]. Ultimately, scientists think, we may be able to create nanocomposites entirely novel substances or "designer materials". Want perfect elasticity in a transparent solid? Strong magnetic properties in an inert, low-cost, sprayable fluid? In ten years you might simply be able to call in your local nano-materials firm and tell them what you need. They will make your material to order.

However, this is mostly long-term stuff: you won't see much nano-science in your daily life for a few years yet. Dr. Dennis Salahub, Director General of NRC's Steacie Institute for Molecular Sciences, believes the real benefits of nanotechnology are yet to come yet come they will. "Projects in nanotechnology research may start out as intellectual curiosities," he says. "But eventually, they will have huge economic value".

As an example, Dr. Salahub cites carbon nano-structures called fullerenes and buckyballs, discovered 20 years ago and named for the visionary US engineer Buckminster Fuller. To visualize a buckyball, look at the geodesic dome from the US Pavilion at Expo'67 in Montreal. Then imagine it smaller by a hundred billion times in length, and a million billion billion billion times in volume. Yet despite their tiny size, or perhaps because of it, fullerene structures called nanotubes are already being explored for commercial video displays.

The engineering in nanotechnology is of a radically different type. From time immemorial, humans have made things; with nanotechnology, we let things make themselves. If this seems like science fiction, consider that Canada's most widely used construction material puts itself together using natural nanotechnology. It's called wood. Trees make wood by combining carbon from the air, hydrogen and oxygen from ground water, and sunlight. There's no reason we can't copy these natural nano-processes ourselves.

In some areas, we already have. One young NRC researcher, Dr. Bob Wolkow, recently startled scientists around the world by persuading a nanotech wire to assemble itself on a silicon substrate. The wire was the thickness of a single atom. Dr. Wolkow (Figure 2) is one member of a seven-person team at NRC that won a 2001 Outstanding Achievement Award for its work in molecular interfaces. The citation was full of phrases such as:

- international recognition,
- new developments in physics, chemistry and biology,
- tools for creating & understanding molecular structures on surfaces,
- the next revolution in microchip fabrication,
- tiny devices that sense, analyze and respond to information in their environment.

Nanotechnology has many potential applications in medicine and health, says NRC's Salahub. Some of Canada's most advanced work along these lines is done in Edmonton. Scientists from the University of Alberta are developing portable "laboratory-on-a-chip" sensors that are so sensitive and rugged that they can detect individual molecules in a fluid sample right at a patient's bedside. Soon waiting for medical-test results may shrink from days or weeks to mere minutes. One Canadian company has already established a market for hand-held blood chemistry analyzers based on nanotechnology. Its markets could grow to several billion dollars per year worldwide. Similar nanotechnology-based devices may revolutionize detection and treatment of cancer, AIDS, diabetes and other scourges.

Figure 2: Dr. Wolkow is one member of a seven-person team at NRC that won a 2001 Outstanding Achievement Award for its work in molecular interfaces. Dr. Wolkow uses the scanning tunnelling microscope to manipulate individual molecules.

Nanotechnology has cautions as well as promises. While Canada participates in a lot of nanotechnology R&D, by world standards its work is insufficient in many fields. "No national strategy has been developed to concentrate the separate pockets of expertise in nanotechnology and nanoscience across Canada," says Dr. Peter Hackett, NRC Vice-President, Research. "Nor has a federal network of Centres of Excellence in nanotechnology yet been created. Yet Taiwan and Korea both have centres for nanoelectronics, China has a 10-years nanotech program for materials and probes, and the US nanotech budget for 2002 alone exceeds half a billion dollars."

Dr. Hackett would like to see Canada take on niche projects that build on our proven national strengths such as electronics, aerospace, biomaterials and pharmaceuticals. That strategy, he says, will let Canada develop nanotech-based businesses that convert new knowledge into jobs and profits.

Admittedly, that process may prove a long haul. Despite its promise, nanoscience is still a high-risk venture that demands massive up-front investment. Many of its new products may take 10 or 20 years to reach consumers, and not all private companies are prepared to invest in such long shots. But despite such cautions, NRC believes nanotechnology is worth the investment in dollars and time.

"I am convinced that within the next few years, the number of Canadian companies commercializing products based on some nanotechnology will increase significantly," says Dr. Yves Deslandes, Chemical Process Director at NRC. Applications could include new types of coating, energy storage, catalysts, and biological devices such as sensors with very tiny pores.

"In the long term, nobody can predict what will happen," Dr. Deslandes concludes. "We simply have to be ready to use our new discoveries."

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About the Editor

Dr. Peter Hackett obtained a Ph.D. in 1972 in physical chemistry from the University of Southampton, England.

He joined the Division of Chemistry of the National Research Council (NRC) as a post-doctorate fellow in 1972. Dr. Hackett is an internationally recognised chemical physicist who pioneered many applications of lasers in chemistry. In July 1995, he was appointed Director General of NRC Steacie Institute for Molecular Sciences. Since January 1998, Dr. Hackett is NRC's Vice-President of Research.

Dr. Hackett is a Fellow of the Chemical Institute of Canada, a Trustee of the Steacie Foundation, an Advisory Editor of Chemical Physics Letters, and a member of the Advisory Board of the International Journal of Research on Chemical Intermediates.

Networking the World in Latin America

by Anna Zyzniewski
IEEE Student Member, Waterloo, ON

1.0 Introduction

IEEE not only acts as a technical exchange forum, but also as a cultural one, which was evidenced at a Region 9 Student Branch meeting. The Region 9 Student Branch Leaders Workshop - Reunión Regional de las Ramas 2000 or RRR2000, which took place in Mexico, gathered IEEE student branch representatives from across South America (Region 9), but also from North America and Europe.

Region 9 is one of the fastest growing regions within the IEEE with an especially significant steady inflow of student members. In 1999, there has been an increase in student membership by 15.4%. That's more than in any other region. Even though IEEE membership is growing in South America, the challenges are numerous.

Student volunteers work very hard to keep their fellow students within the IEEE organization, and try to attract new members. Two branches from Peru and Brazil respectively expressed concern that IEEE still needs to regain confidence in the region. Members view the organization as a technical magazine subscription (which are often delivered late or not delivered at all). Another branch in Guatemala needed to rebuild itself as it was "forgotten", therefore students had to regain credibility by gaining support of the dean of engineering at their university. But some student branches, such as one in Argentina, did not even have full support from the professors in the electrical engineering department. Thus, students in these regions often feel that they have to work very hard just to receive minimal attention and support locally to effectively run student branches.

2.0 Why are student congresses needed?

Student IEEE members are often unaware of the opportunities within the IEEE. One of the reasons is that crucial information does not always percolate as fast to members that are at the bottom of the organization's structure. This conference was an excellent source of information gathering and exchange.

For example, many were unaware of the scholarship opportunities that are available from the IEEE and its societies such as the Computer Society. Only a few students at the meeting were a member of an IEEE technical society, which means that the benefits of those society memberships are poorly understood. The conference also showed that students were often unaware of the opportunities that can be found within IEEE. One of the reasons is that they often do not contact IEEE representatives due to a more reserved email etiquette in their countries and to the language barrier.

IEEE not only acts as a technical exchange forum, but also as a cultural one.

Most of the discussions during the workshop were geared at strategies to attract new members to student branches. This meeting, therefore, enabled ideas to be exchanged in an interactive and informal way.

3.0 How to grow student branches?

One of the obstacles in attracting new members in South America is the language barrier since IEEE information is disseminated practically only in English. The members feel it is essential that some of the information be disseminated in their native language to attract new members, as well to keep active members within their districts [Editor's note: the IEEE is now thinking of translating certain static information such as application forms into the five United Nations languages]. One of the recent achievements in attracting new members has been the production of a video promoting the Graduates of the Last Decade (GOLD) program in Region 9 that was put together in Spanish and in Portuguese.

In one of the sessions students presented challenges and successes within their branches. Here is a list of some interesting ways that were used to attract new members:

- Make presentations and informative sessions for first year students,
- Close the gap between academia and the corporate world by inviting speakers from local companies for a company-sponsored luncheon presentation,
- Advertise the benefits of paper publishing on undergraduate level,
- Create alliances with local professional organizations, other than the IEEE,
- Run social events such as dances as a way to market the IEEE,
- Invite professors to talk about their own research, scientific interests and career paths,
- Undertake social events with student members such as a skiing trip in the winter, or hiking in the summer,
- Build a strong portfolio of past events to build a reputation to attract future student members, and
- Delegate work to existing student members and make them feel like they own the branch or society chapter.

A follow-up workshop allowed participants to brainstorm ways of improving activities within the student branches. A group brainstorming exercise was conducted by dividing participants into groups addressing different activities: membership retention, attracting new members, leadership, fund raising, communication, and new events.

4.0 So what's next?

The first meeting which attracted students from a number of regions took place in Netherlands in 1999 and had 60 participants. The student branch leadership workshop in Mexico was the second meeting to attract students from regions other than the host region. This conference showed yet again that IEEE student branches are very active. Furthermore, student members were raising vital questions to the future survival of the IEEE.

The success of this meeting was evident through the enthusiasm and participation of all students. Now, students are also planning an IEEE global student conference and feel it is a necessary next step to further remove boundaries and allow for the flow of information between all parts of the world.

The next Region 9 student workshop will take place in Brazil in November 2001 while the next Region 7 student workshop will be in Calgary in late September 2001. I strongly urge any branch leader and student members to take part in these workshops. It has been a tremendously enriching experience for myself and the other participants. Finally, I would like to acknowledge the generous support from the IEEE Foundation, which made it possible for students from various regions outside of Region 9 to participate in this gathering.

About the author

Anna Zyzniewski completed M.A.Sc. in Systems Design Engineering at the University of Waterloo in June 2001. Her experience encompasses working for engineering consulting firms in Canada and in Japan, the steel industry, and the Canadian government. From September 1999 to October 2000, she was in Japan as a visiting researcher at Kyoto University and an intern at the United Nations Environment Programme (UNEP). She has been an IEEE student member since 1999. She is currently the student member on the IEEE Women in Engineering Committee. She may be reached at anna@ieee.org.

Run for the Border and Don't Forget Your Passport, IEEE in Latin America

by *Ian Tien*
Chair, University of Waterloo IEEE Student Branch A

1.0 Welcome to Mexico, land of adventure.

Mark Twain once said that "travel is fatal to prejudice, bigotry and narrow-mindedness - all foes to real understanding." Indeed my preconceptions of Mexican culture, based largely on Speedy Gonzales cartoons, were instantly shattered by the real Mexico, a breathtakingly beautiful country filled with tradition, song and genuine good will.

What I remember most is the bus ride into Zacatepec on the first morning of the conference, watching the equatorial sun glide across the wide blue sky, over straw-coloured oceans of corn and sugarcane. In the distance volcanically dormant mountains, green with vegetation, stood majestically across the whole horizon. Their presence, a corporeal reminder of how different things would be inside this strange new world.

Delegates on the bus ride to Zacatepec.

2.0 The Region 9 Student Branch Conference

The Institute of Electrical and Electronic Engineers is a worldwide organization geographical divided into 10 regions. Mexico belongs to Region 9, which represents the whole of Latin America and the Caribbean. This year, the organizers of the Region 9 IEEE Student Branch Conference (Reunión Regional de Ramas 2000), organized by the Zacatepec Institute of Technology, sent out an open invitation for observers from extra-regional student branches. Foreign delegations in attendance included Canada (Region 7), Germany (Region 8), Turkey (Region 8) and the United States (Regions 3 and 6).

One of the primary goals of the conference was to bring together student leaders from across the continent to network and share experiences of the challenges and successes they've encountered in running their student branches.

The three-day conference in Zacatepec included presentations on IEEE Region 9, the IEEE Computer Society, Student Branch organization, and the IEEE Graduates Of the Last Decade Program. Other events included a leadership workshop on strategic thinking and a set of group discussions on common student branch issues such as fund raising, leadership development, and recruitment.

Presentations and discussions were conducted primarily in Spanish and interaction with foreign delegates was facilitated through the use of simultaneous translation.

3.0 IEEE in Latin America

Attending the sessions.

The Latin American and Canadian IEEE Regions share a lot in common. Both are among the smallest IEEE Regions in the world, with memberships of approximately 14,000 and 12,000 respectively. The focus and format of the Latin American workshop sessions were similar to those presented at the Canadian student branch meeting held a month earlier in Montreal, Canada.

One of the most significant differences between the two regional conferences was the degree of cultural exchange that took place among delegates. As the Latin America IEEE region is made up of 18 culturally distinct countries, the second night of the student branch meeting was reserved for an exhibition of customs and traditions from around the continent, from the Mexican Sombrero dance to the Brazilian Sampa. The exchange also included the sampling of special foods and delicacies, such as milk caramels from Argentina, sugar cane spirits from Brazil, and spiced fruit jellies from Guatemala (and of course maple sugar cookies from the far reaches of the Pearson International Airport in Toronto).

At Zacatepec, the most productive information exchanges seemed to occur not only through the formal presentations but also during the informal social events interwoven across the conference program.

Building a strong and sustainable membership ranks among the top priorities of every IEEE Region, however Latin America faces a distinct set of challenges.

Though its student membership program is strong and growing, some find the transition from student to professional membership arduous and bureaucratic. The administration appears to be slow in sending out registration confirmations, and there is no way to track the status of an application during the registration process. Furthermore, some feel that there have been IEEE applications denied without sufficient reason.

Application uncertainty, administrative inconvenience, and additional financial cost above that of student membership fees have been outweighing the benefits of professional IEEE membership in an increasing number of cases.

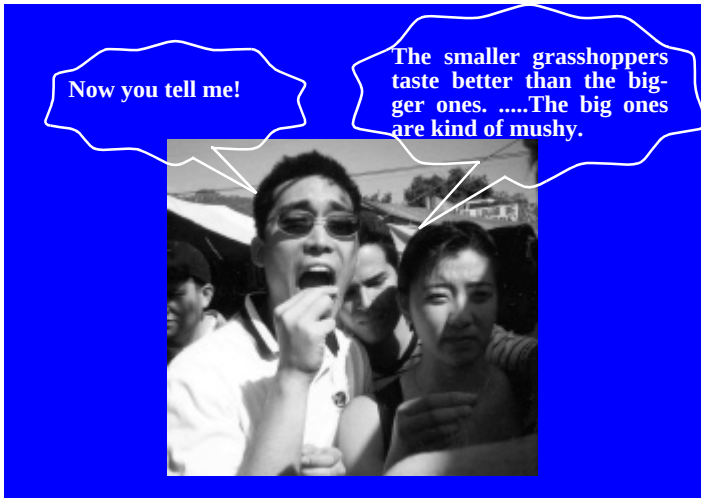
Another concern is that post-secondary enrollment into IEEE-related fields may be declining. As free trade continues to level the competitive playing field, many electrical engineering professionals in Latin America are having their skills compared against professional accreditation requirements, requirements that some feel are unreasonably rigorous. The fear of not being granted a degree upon graduation has students shying away from engineering programs.

One of the new initiatives taken to revitalize interest in the IEEE is the Graduates of the Last Decade, or GOLD, program. Region 9 has recently funded a professionally-produced video presentation promoting IEEE, the GOLD program, and the benefits of GOLD membership. The presentation is approximately half an hour in length, narrated in Spanish, and available for use by any branch or section in Region 9.

Indeed the establishment and maintenance of an active membership base is a challenge universal across all regions. One of the many lessons of the Region 9 conference was that IEEE sections and branches must constantly re-examine the value proposition of their membership, working to refine not only program benefits, but also in communicating the advantages of IEEE membership to members and potential members alike. Indeed, for the sixty-odd attendants at this year's Region 9 student branch conference the benefits of IEEE membership were crystal clear, a continent of friendships and a world of new understanding.

IEEE aside, I learned three things:

1. If you eat a big, mushy fried grasshopper, you will probably have a grasshopper-related nightmare sometime in the next two weeks.
2. You can learn Spanish in five days, but no one will understand what you're trying to say.
3. If a bathroom door is labeled with a word you cannot decipher, do not assume it says "Mens" and walk on in.



Workshop delegates.

About the author

Ian Tien is Chair of the University of Waterloo IEEE Student Branch A and past president of the University of Waterloo Engineering Society. His industry experience to date has been based largely in interaction design and enterprise software development, working for companies such as the TorontoStock Exchange, E*Trade Canada, Trilogy, and SpaceWorks Inc. He will be graduating with a BASc in Computer Engineering from the University of Waterloo in 2002. He can be reached at itien@engmail.uwaterloo.ca.

Breakfast at the youth hostel (clockwise from the left): Piqui, Isabel, Luanne, Anna, Rosio.

An IEEE Cultural Exchange

by Luanne Winchiu

IEEE Student Member, University of Carleton, Ottawa, ON

This year, RRR2K was held from 9-11 November in Zacatepec and Oaxtepec, Mexico. This workshop is hosted annually by a student branch in Region 9 and brings together the executive committee of all the student branches in the region for a leadership and team building session.

Presentations were given on the structure of the IEEE, as well as the GOLD program and the IEEE Computer Society. A very informative and motivating presentation on starting a business was given by Dr. Gaspar Sanchez Mejorada, which was well received by all. By participating in a conference from another region, one can see the accomplishments achieved by the student branches and bring back to one's own branch new ideas and tips for successful events.

How often does one meet people from Mexico, Brazil, Bolivia, Peru, Turkey, Costa Rica, Germany, Canada and many more countries in only 4 days? This cultural exchange was most noticeable in a cultural evening held on the first night of the conference where dances, foods, songs, flags and coins were shared by each country. Coming from Canada, the cultural experience was very rewarding as I learnt to salsa, sing and speak in Spanish, eat grasshoppers and cacti and climb up an Aztec pyramid!

The purpose of these workshops is mainly for the student branches of one region to share ideas and motivate one another for the upcoming school year. By attending a conference outside one's own region, not only is this achieved, but also the IEEE slogan “Networking the World” is suddenly realized. The invaluable leadership and cultural experience gained, as well as a strong network of support and friendship makes a conference like this worthwhile for any IEEE member.

Mariachi (Mexican musicians) at lunch in Oaxtepec.

About the author

Luanne Winchiu is currently completing her third year in Electrical Engineering at Carleton University. She is an active member of the IEEE Carleton Student branch and was Treasurer for the past year. She was recently awarded the IEEE McNaughton Scholarship. Her favourite past times include discovering different cultures and travelling, volunteering in the community and rollerblading along the Rideau Canal. She may be reached at luanne.winchiu@ieee.org

Real-Time Generation Control

by *Patrick Toner, Jean Pierre Turgeon, Alain Verreault*
SNC-Lavalin ECS, Montréal, QC

Abstract

Generation scheduling and control is an important component of daily power system operation. The overall objective is to control the electrical output of generating units in order to supply in an economical manner the continuously changing customer power demand. Much of this functionality is provided by Automatic Generation Control (AGC) and related functions operating within a utility control centre Energy Management System (EMS).

This article describes the generation control functions developed by the SNC-Lavalin Energy Control Systems Inc. as part of its EMS product line. This Generation Management Subsystem (GMS) has been designed and implemented for efficient and reliable operation in real-time, allowing real-time monitoring and hierarchical control of generation resources.

Sommaire

La planification et le contrôle de production d'énergie est une partie importante de l'exploitation quotidienne d'un réseau électrique. L'objectif général est de contrôler la puissance fournie par des unités de production d'énergie afin d'alimenter de façon économique l'appel de puissance, en continuel changement, de la clientèle. Une grande partie de cette fonctionnalité est fournie par un Contrôle de production automatique (Automatic Generation Control - AGC) et des fonctions connexes opérants sous un Système de gestion d'énergie (Energy Management System) d'un centre de contrôle. Cet article décrit les fonctions de contrôle de production développées par SNC-Lavalin Systèmes de contrôle de l'énergie Inc. dans sa ligne de produits EMS. Ce Sous-système de gestion de production (GMS) a été conçu et mis en oeuvre pour une exploitation en temps réel efficace et fiable, permettant une surveillance en temps réel et un contrôle hierarchique des ressources de production d'énergie.

1.0 Introduction

Power system loads are sensitive to frequency and following system frequency changes the aggregate load change follows the frequency deviation. When a generating unit is tripped or additional load is added to the system, the power mismatch is initially compensated by an extraction of the kinetic energy from the system inertial storage (the spinning masses) that causes a system frequency drop. As the frequency decreases the power consumed by loads also decreases. Equilibrium for large systems can be obtained when the frequency sensitive reduction of loads balances the power output of the tripped unit or that delivered to the additional load resulting in the new frequency. This effect could stop the frequency decline in less than a couple of seconds. However, if the mismatch causes the frequency to deviate beyond the governor deadband of the generating units their output will be increased by governor action. For such mismatches, equilibrium is obtained when the reduction in power consumed by loads plus the increased generation due to governor action compensates the mismatch. Such equilibrium is normally obtained within a dozen seconds of the frequency incident.

Governor droop is the percent change in frequency that would cause unit generation to change by 100% of its capability. Typical speed droops for active governors are in the range of about 4%. With this level of frequency sensitivity and at the expense of some frequency deviation, generation adjustment by governors provides ample opportunity for follow up manual control of units.

This automatic adjustment of generation by free governor action is known as primary frequency regulation. The objectives of the follow up control especially under normal changes of load, are to return frequency to schedule, to minimise production cost, and to operate the system at an adequate level of security. Automatic Generation Control (AGC) (also known as secondary frequency regulation) is a closed-loop control system that partially replaces this manual control.

This form of generation control has become essential to the real-time operation and control of interconnected power systems and operates in widely varying power system control environments ranging from autonomous to strongly interconnected systems with hierarchic multi-level control.

Compared with generation based frequency control, generation based reactive power or voltage control is less standardised and less automated. Primary voltage control involves keeping generator terminal voltages at their setpoint values by means of controls, automatic voltage regulators, which operate as part of the generating unit excitation system. This automatic correction compensates against random variation in the transmission network within a few seconds.

Few countries in the world have semi-automated, secondary voltage control of generators. The main objective of the secondary level voltage control is to update the set points of generator exciters to maintain voltages at critical points within pre-defined deviations as reactive power demand and generation deviate from their scheduled values. These scheduled values can be provided by tertiary voltage control i.e. Real-time Optimal Power Flow applications.

Figure 1: Ningxia Autonomous Region Generation Control Centre, China.

Automatic Voltage Control (AVC) is an implementation of secondary level voltage control at the generating plant level. The objective of this plant control also known as Joint Voltage Control is to maintain the high-side voltage of the step-up transformers equal to specified values while avoiding reactive power interchange among the plant units.

SNC-Lavalin ECS has supplied generation control software integrated with SCADA as part of its “GEN-3” EMS product line to a wide range of customers throughout the world.

In 1995, the first “GEN-3” dispatch-level EMS was commissioned at the Ningxia Autonomous Region Generation Control Centre in China (Figure 1).

More recently, both AGC and AVC were delivered as part of a “GEN-3” Hydro GMS recently commissioned at the 10, 000 MW Guri Hydroelectric power plant on the Caroni river in Venezuela (Figure 2).

This article describes the generation control functions and related software architecture developed by the SNC-Lavalin Energy Control Systems Inc. as part of its EMS product line.

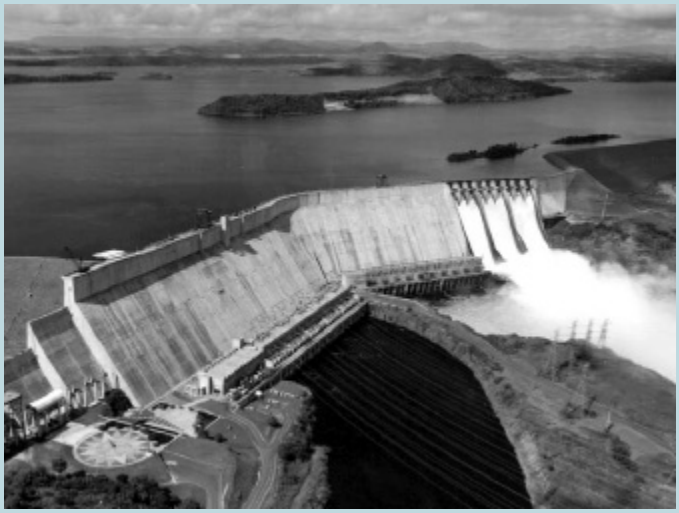


Figure 2: Guri dam, Venezuela.

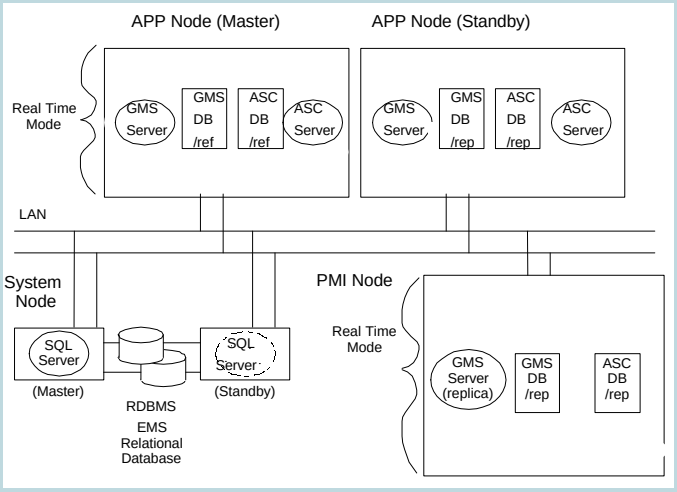


Figure 3: System Architecture Configuration.

2.0 ECS Software Architecture

The ECS system comprises a Supervisory Control and Data Acquisition (SCADA) subsystem, and advanced application subsystems such as Network Analysis and Security (NAS), Operational Planning and Scheduling (OPS) and the Generation Management Subsystem (GMS).

The system is implemented with multiple processing units (nodes) that are connected together by a Local Area Network (LAN). The system uses a homogeneous hardware/operating system (Unix) platform for its processors.

The Figure 3 below presents the consolidated EMS configuration consisting of the System (SYS), Data Acquisition (DAC), Application (APP), and Person-Machine-Interface (PMI) nodes.

SCADA executes on redundant Data Acquisition (DAC) nodes that have special hardware interfaces for communication lines to the Remote Terminal Units (RTUs) to perform the data acquisition tasks. RTUs are data acquisition units placed at various locations throughout the power system to collect data and perform remote control.

The advanced application such as GMS can execute on the DAC nodes or more usually on a redundant pair of Application (APP) nodes. Data processing and application calculations are performed on the different server nodes, for example DAC and APP, and results are distributed to the other server nodes and the operator workstations, known as PMI nodes.

The SYS node contains the EMS relational database tables.

2.1 GMS Software Architecture

The GMS architecture is characterised by application programs such as AGC, Economic Dispatch, AVC and Spillway Gate Control, a GMS server process and a memory-resident database. The server process schedules and executes all of the GMS applications and provides remote access from the PMI nodes.

The GMS memory-resident database (GMS/m) and related services are responsible for storing all GMS data i.e. static data, application control parameters and application results. The GMS/m provides a central data storage and retrieval mechanism for data that is used very frequently and allows many processes to access the information at the same time.

The EMS relational database (EMS/r) includes the static data description of the power system and organises data for specific uses, for example, GMS data. GMS interfaces with the relational database for the static population of the GMS/m and handling edits of GMS data in the relational database

Like all other ECS processes, the GMS server is a redundant process and maintains a reference copy of the GMS/m on one of the APP nodes, referred to as the reference node for this “reference” server. The server on the other available APP node acts as a standby “replica” for the reference server. The PMI nodes as well as the standby APP node have their “replicated” database maintained by data propagated from the reference APP node.

When the GMS reference server process fails or the APP node on which it is running fails, the standby server takes over from the failed reference server and thus becomes the new reference server. When the failed reference server recovers, the full database is downloaded from the reference and it starts as a standby. This “failover” strategy ensures high availability for application programs.

2.2 Real-time Data from SCADA

The SCADA subsystem includes telemetry scanning, data processing, output co-ordination (controls to RTUs, strip chart, mapboard updates and data links) and calculated point computation.

The data acquisition programs obtain measured data from the data links and RTUs, validates, converts and stores the data in the real-time SCADA database. This database is organised on a point (measurement) basis and analog, status (digital) and accumulator points are supported. GMS receives notification of selected point updates, for example unit MW generation, frequency, tie line MW.

Supervisory control applications provide the capability to control field devices associated to SCADA points. Discrete, incremental (raise/lower) and setpoint controls are supported. GMS interfaces with these supervisory control applications to send, for example, generator MW and generator Mvar setpoint commands and spillway gate position commands.

2.3 Alarming

One of the primary goals of GMS is to provide real-time monitoring of generation resources and to support dispatchers in taking corrective action. Using the standard ECS alarming services audible and visual indications are provided to the dispatcher when abnormal conditions arise. The dispatcher is also notified of other events occurring on the system, for example, dispatcher actions.

Presentation control allows priorities to be assigned to alarms and provides alarm acknowledgement and alarm inhibiting.

2.4 User Interface

Real-time displays present GMS data in variety of formats. Multi-headed, full-graphics consoles form the primary interface to the GMS applications. Standard input devices include an alphanumeric keyboard and a three-button trackball or mouse.

Each full-graphics console operates as an independent workstation, performing all display processing locally. Display data is maintained in local memory and on disk and as mentioned previously, real-time GMS database updates are continually provided to the workstation via the replicated database communication facilities. The data broadcast scheme provides continuous exception updates to the workstation

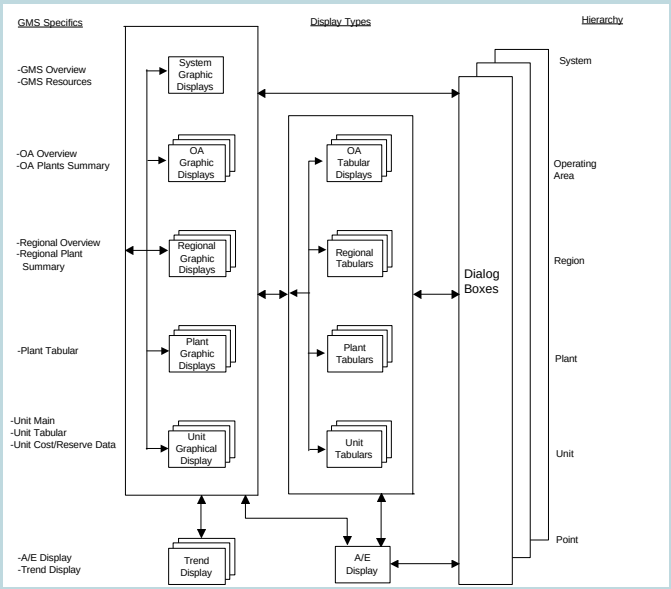


Figure 4: GMS Operational Displays Tree, Based on Power System Hierarchy Levels.

database.

All application user-interfaces are implemented in X-windows using the Motif widget set. These widgets provide standard user-interface objects such as push buttons, list, menus etc. Motif controls the display and handling of these widgets, thus ensuring a consistent “look and feel.”

Display types include graphical summary displays, dialogs and menus, tabular displays and trend displays (Figure 4).

3.0 Hierarchical Generation Control

3.1 Introduction

The principles of AGC are well known and relatively straightforward in terms of control theory. However, AGC implementation depends on the regulating strategy of the particular utility and its place in a well-defined national or international regulating hierarchy. GMS products have been developed for different levels in the control hierarchy.

The Dispatch-Level GMS performs real-time monitoring and control of generation resources to ensure economic and secure operation of interconnected power systems at a national or regional level as part of a conventional EMS.

The Hydro GMS performs real-time monitoring and control of hydraulic resources to ensure the control of generation, voltage and water spillage in one or more large hydroelectric plants.

3.2 Dispatch-Level

The GMS supports multi-control area and multiple "pre-defined islanding" configurations and consequently can be employed for varied national and regional level control schemes to control and monitor regulating entities: control areas, power plants and generating units in order to meet the following operational objectives:

- Load-frequency control,
- Tie-line control of interconnected systems,
- Time error correction,
- Inadvertent energy exchange monitoring and control,
- Control of generation regulating entities,
- Economic operation of generating units,
- Performance monitoring,
- Production cost accounting.

GMS can support multiple independent control areas. The Operating Area Configurator application monitors the network electrical connectivity and can detect pre-defined configurations corresponding to known control areas. When an unknown configuration is detected the execution of the AGC is suspended.

The GMS system takes into account the economics of operation through its Economic Dispatch function. Typically, every 5 minutes Economic Dispatch distributes the current load among the generators so as to minimise the cost of generation. The generator MW output determined by ED is then used as a base point by AGC.

AGC aims principally at maintaining frequency and/or interchange levels at prescribed values. It calculates MW set points for controlled generators. The set points are determined as deviations from the ED calculated base points. As secondary objectives AGC tries to correct inadvertent energy interchange and time error.

During the course of the day and in spite of the control exerted by AGC, the total net energy exchange (defined as the algebraic sum of the integrals of tie-lines power flows over time) may be biased towards too much export or too much import. Utilities have agreements specifying when and at what rate those errors must be corrected and AGC includes features allowing it to bias its interchange objectives in the desired direction.

It may also happen that, over a period of several hours, the average frequency tends to be either too low or too high. The integral of the frequency has dimension of “cycles” so, the cycle being equal to 1/60th of a second at normal frequency in North America, this quantity is termed the time error of the system. Again, utilities must keep that error as close as possible to zero and AGC can, given the error and the period over which the error must be corrected, bias its frequency target in order to eliminate the time error.

In addition to its control functions, GMS includes Reserve Monitor and Production Cost Monitor functions. The Reserve Monitor keeps track of the MW and MVAR reserves, and generates alarms when reserves become too low while the Production Cost Monitor calculates the cost of generation for both power and energy.

3.2.1 Main features

- Linear and adaptive area control error filtering,
- Proportional-Integral controller,
- Setpoint control and pulse control commands,
- Equal incremental cost dispatch,
- Cost function based on heat rate data, discharge rate curves or bid-price data,
- Inter-regional transfer limits,
- Dispatch of multiple plant and fuel types,
- Retrieval and write-back of measurement (SCADA) data,
- Online database updates and parameter validation,
- Interface with Network Analysis and Security Subsystem,
- Interface with Operations, Planning and Scheduling Subsystem.

3.2.2 User-Interface

- Graphical and tabular representation of generating unit monitoring, dispatch and control data
- Graphical representation of area control error, frequency and interchange
- Graphical representation of area, plant and unit reserves
- Summary, execution and control displays for AGC, Economic Dispatch, Reserve Monitor, Production Cost Monitor

3.3 Hydro GMS

The GMS can also be employed for varied hierarchical control schemes, ranging from regional hydro generation dispatch centres to hydro plant generation control centres to provide co-ordinated voltage and frequency control and monitoring and control of reservoir flows. More specifically, the GMS applications are used to monitor and control hydraulic generation resources in order to satisfy various operational objectives:

- Load-frequency control,
- Control of generation regulating entities to maintain generation targets,

Figure 5: AGC Control Area Summary Display.

- Economic operation of generating units,
- Topology processing for plant connectivity,
- Joint Var Control of generating units within a plant to control voltage and avoid reactive power interchange between units,
- Monitoring and control of reservoir outflows,
- Performance monitoring.

In other words, the GMS hydro applications are the basic functions for real-time monitoring and control of the generating units within a hydro power plant. Automatic Generation Control (AGC), Generation Dispatch (GD), Reserve Monitor (RM), Spillway Gate Control (SGC), Network Topology Processor (NTP) and Automatic Voltage Control (AVC) are the main GMS hydro applications.

The AGC application controls MW output of online regulating generators with the objective of maintaining the system frequency and desired generation levels within specified bounds.

The RM application calculates the available real and reactive power reserves within a plant. Different reserves are calculated as a function of different unit limits and plant conditions.

The GD application computes base points and participation factors for qualified units in the power plant to achieve a selected operating objective. The computed base points and participation factors are used by AGC to allocate generation control errors among qualified units.

The NTP application monitors the connectivity of the main busbars in the plant switchyard and the connectivity of the electrical devices connected to the main busbars.

The SGC application controls opening of the plant spillway gates in order to achieve a specified total plant release or gate position. The user can manually enter the required release or a scheduled value can be used.

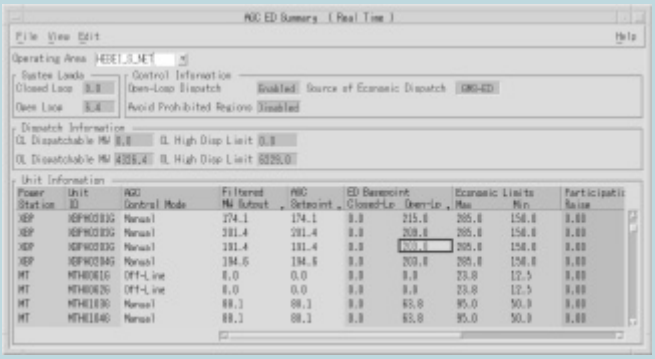


Figure 6: AGC Generating Unit Tabular Display.

The AVC application regulates the voltage on a selected plant busbar by controlling generating units' reactive power generation.

During normal operation, these objectives are carried out by the applications executing automatically at pre-defined intervals. But they may also be launched in response to pre-defined events or on dispatcher demand when manual intervention is required.

3.3.1 Main features

- Linear and adaptive control error filtering
- Proportional-Integral Controllers
- Setpoint control and pulse control commands
- Minimization of the water discharge level using the equal incremental cost dispatch
- Balanced load factor dispatch according to MW capacities
- Generating unit Mvar dispatch
- Open-loop and closed-loop control of spillway gates
- Retrieval and write-back of measurement (SCADA) data
- Online database updates and parameter validation
- Interface with Operations, Planning and Scheduling Subsystem

3.3.2 User-Interface

- Graphical and tabular representation of generating unit monitoring, dispatch and control data,
- Graphical representation of control error (MW, Mvar, kV and spillway flow), frequency and plant generation (MW and Mvar), voltages and spillway flows,
- Graphical representation of plant connectivity and equipment using dynamic bus colouring,
- Graphical representation of reservoir elevation, release and gate positions,
- Summary, execution and control displays for Automatic Generation Control, Generation Dispatch, Reserve Monitor, Automatic Voltage Control and Spill-way Gate Control.

4.0 Future Challenges

4.1 Generation control in a market environment

Since the generation applications were originally developed for vertically integrated utilities, the advent of de-regulated energy markets is providing significant challenges. In terms of generation control, the evolution of power system operation into a market structure requires that the provision of secondary frequency control and reactive power support by generating units become marketable ancillary services.

The evolution to a market-based AGC and the handling of ancillary services are among the most significant changes for generation functions.

4.1.1 Market-based AGC

- AGC modifications to accept external generating unit basepoints and external ACE signals from the Independent System Operator (ISO),
- Modified load following for the market environment,
- Replacement of conventional, “cost of operation” economic dispatch by a market-based dispatch, based on price,
- Checking the mismatch between the actual power and contract power: Balancing Energy and Ex-Post pricing function,
- Support dynamic scheduling: transfer of AGC regulation components between control areas by dynamic interchange scheduling,
- Monitoring of unit regulation performance.

4.1.2 Market-based Reserve Monitor

- Support schedules for regulation and reserves (transient or primary, regulating, spinning, operating) and reactive support i.e. ancillary services,
- Monitoring and checking the reserves contracts,

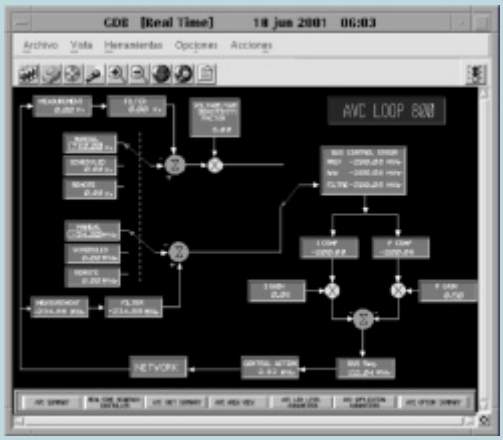


Figure 7: Automatic Voltage Control Summary Display.

4.2 IT Infrastructure

The evolution of existing EMS functions to meet market requirements and the provision of interfaces to the many, emerging market functions and information systems is continuing to provide important technical challenges for EMS vendors such as SNC-Lavalin ECS.

In the evolving deregulated environment, the various players, generation companies, transmission companies, distribution companies, power exchanges, scheduling coordinators, ancillary service providers and the independent system operator require increasingly reliable, expandable and above all open information systems that can safely manage and securely exchange both trading and settlements data, scheduling data and power system operational data.

4.3 Secondary Voltage Control

Some utilities already use a hierarchical real-time voltage control and reactive power control system with the addition of secondary voltage regulation to the automatic voltage regulation of generators.

The choice of performing the voltage control by the adoption of multi-level hierarchical structures seems to be (especially in Europe) more and more attractive for the reactive power production of regions within a larger power systems.

This application should be further developed to provide a generalised hierarchical real-time voltage control. Such a control system poses significant technical challenges but would have an important role to play in real-time closed-loop voltage control.

5.0 Further Reading

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Figure 8: Spill-way Gate Control Summary Display.

In June 2000, SNC-Lavalin Inc. acquired 100 percent ownership of the Energy Control Systems Division of CAE Electronics Ltd., and a new company - SNC-Lavalin Energy Control Systems Inc. was established. SNC-Lavalin Energy Control Systems Inc. develops and delivers energy control systems (ECS) to a wide range of power utilities. The ECS product line includes a Supervisory Control and Data Acquisition (SCADA) System as well as an Energy Management System (EMS) for generation and transmission network monitoring and control and a Distribution Management System (DMS) for substation and distribution network monitoring and control. This "GEN-3" product line is based on an open, distributed architecture and is in operation in various utility control centres throughout the world.

About the authors

Patrick Toner holds B.Eng. and Ph.D. degrees in electrical engineering from the Queen's University of Belfast, N. Ireland. He is a group leader in the SNC-Lavalin ECS division. He is an associate member of the IEE, member of the IEEE and member of the Ordre des ingénieurs du Québec.

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Speech Recognition by Intelligent Machines

by *Hesham Tolba & Douglas O'Shaughnessy*
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Abstract

The goal of Human-Machine (HM) technology is to create artificial intelligent machines that can interact with humans via voice. Explosive advances in the different fields of digital computing, signal processing and the evolution of statistical methods in the last ten years helped the huge progress and growth of HM research. However, the creation of such machines remains a distant goal. This is mainly due to the lack of a fundamental understanding of human speech processing. In this paper, we give an overview of human-machine technology with emphasis on Automatic Speech Recognition (ASR). Finally, we conclude with some perspectives about fundamental limitations in the current technology and some speculation about where we can go from here.

Sommaire

Le but de la technologie “interaction homme-machine” (HM) est de créer des machines artificielles intelligentes capables d'interagir avec les êtres humains par l'intermédiaire de leurs voix. Les progrès rapides dans les différents domaines tels que les calculs numériques, le traitement des signaux et l'évolution des méthodes statistiques au cours des dix dernières années ont contribué énormément au progrès et à la croissance énorme de la recherche sur la technologie HM. Cependant, la création de telles machines demeure encore un but éloigné. Ceci est principalement dû au manque d'une compréhension fondamentale du traitement de la parole par l'être humain. Dans cet article, nous donnons un aperçu globale de la technologie HM tout en mettant l'accent sur la reconnaissance automatique de la parole. Finalement, nous concluons avec quelques perspectives au sujet des limitations fondamentales de la technologie courante, et les axes de recherche les plus prometteurs pour améliorer cette technologie.

1.0 Introduction

The aim of human-machine technology is to create intelligent machines capable of decoding spoken information and acting appropriately upon that information, and then speaking to complete the information exchange [1]. However, the creation of such intelligent machines still remains a distant goal. Two challenging areas of speech research are still far from being mature enough to create such machines: automatic speech recognition (ASR) [2] and speech synthesis. For example, most existing ASR systems used for practical applications are of the small-vocabulary or isolated-word type. Medium- and large-vocabulary systems perform well in laboratories but not in real life [3] i.e. the field of ASR is in its early infancy. As well, synthesized speech is still far from natural speech [1]. The objective of this paper is to provide an overview of human-machine technology with emphasis on ASR.

2.0 ASR and its Difficulties

ASR can be described as the decoding of speech information using a machine (Figure 1). This decoded information can then be used to perform various tasks such as producing written text, controlling a machine or accessing a database, telephone voice dialing, and hands-free applications such as car phones. Huge progress in ASR research has occurred during the past four decades. However, the desired goal of a machine that can understand a spoken utterance on any subject by all speakers in different environments is still far from being achieved because of the associated difficulties. These difficulties include: inter- and intra-variability of speakers, the nature of the utterance (continuous speech versus isolated words), the vocabulary size, the complexity of the language and the robustness of such recognizers against different environmental conditions under which the recognition operation is performed. Although many of these problems have already been partially solved, there are still significant obstacles to be overcome before large-vocabulary continuous speech recognition systems can reach their full potential. In this section, we overview briefly the difficulties of ASR processes.

2.1 Adverse Conditions

A robust ASR system can deal with a broad range of applications and adapt to unknown conditions [6]. In general, the performance of existing speech recognition systems, whose designs are predicated on relatively noise-free conditions, degrades rapidly in the presence of adverse conditions. It was found that recognition accuracy for a typical speech recognizer drops from 96% for clean speech to 73% as the signal-to-noise ratio (SNR) is decreased to 20 dB, and it drops to 31% at 10 dB SNR. However, a recognizer can provide good performance even in very noisy background conditions if the exact testing condition is used to provide the training material from which the reference patterns of the vocabulary are obtained, which is practically not always the case.

In order to cope with the mismatched (adverse) conditions, different approaches could be used. Two fundamentally different approaches have been studied for achieving noise robustness. The first approach pre-processes the corrupted speech input signal prior to the pattern matching in an attempt to enhance the SNR. The second approach modifies the pattern matching itself in order to account for the effects of noise. Methods in this approach include noise masking, the use of robust distance measures, and HMM decomposition.

In addition to the above techniques, in certain applications, where training and testing can be done under the same noisy conditions, acceptable recognition performance can be obtained. It has been shown that this multi-style training improves the performance substantially under stress and with different speaking styles, under normal conditions by compensating for day-to-day speech variability. It can also be used when a recognizer cannot be trained under live stress conditions. Multistyle training reduces the error rate by more than a factor of two from 20.7% to 9.8%. The drop in the error rate is large, 6.2% to 2.9%, even for normally spoken words, and greatest for Lombard and angry conditions.

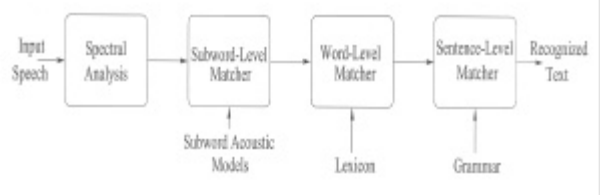

Figure 1: Block diagram of a typical continuos speech recognition system.

2.2 Inter- and Intra-speaker Variabilities

The inter- and intra-speaker variabilities in speech sounds include different speaking styles, speaking modes, diverse accents, poorly articulated speech, speaker stress, and disfluencies. Speaker noise includes the Lombard effect, uncooperative speakers, lip smacks, breath noises, pops, clicks, coughs, laughter, and sneezes. These variabilities result in two main categories of speech: read and spontaneous. These two types of speech differ not only in the way they are produced, but also in the way they are perceived. This was proven in different studies by showing that listeners can differentiate between the two speech types, even when lexical, syntactic, and semantic structure are identical. Although the perceptual distinction of the two types of speech is quite evident, it is not clear which perceptual cues enable such a distinction. However, in both cases, speakers include certain information in speech that enables listeners to recover words, and listeners apply what they know about the spoken language in order to understand such spoken speech. Several cues for word perception are used to recognize words. These cues include: the word itself, syntax and semantics, in addition to prosodic features.

2.3 Other Difficulties

In general, read speech is characterized by its monotony, fluency and correct syntax; however, spontaneous speech produces a rhythmic sensation and could be disfluent. Such disfluencies include: more hesitations and pauses, repetitions and repairs, false starts, pauses (either filled (vocalized), e.g. "uh", "um", etc., or lexicalized, e.g. "well", "like", and "you know", or unfilled (silent)), laughter and coughs, longer and nonuniform-distributed unfilled pauses. Beside disfluency, spontaneous speech is characterized by: pronunciation variation due to accents, coarticulation and speaking mode, phoneme deletion or phonemes shortened, less vowel reduction, sentence stress of some important words in terms of: pitch movement, variation of spectral characteristics (intensity), lengthening [10].

All of the above-mentioned disfluencies and the associated problems of spontaneous speech render the ASR process much more difficult and reduce the performance of recognizers.

3.0 Different Approaches for ASR

In general, there are two approaches to speech recognition, namely the acoustic-phonetic approach, and the pattern recognition-based approach. In the first approach, continuous speech can be segmented into well-defined regions which can then be given one of several phonetic labels based on measured properties of the speech features during the segmented region. Thus, characterization of the features of basic speech units can be found and speech can be labeled as a continuous stream of such phonetic units. Then, a mapping of the sequences of phonemic units into sequences of words is produced by the lexical decoding.

On the other hand, in the pattern recognition-based approach, the basic speech units are modeled acoustically based on a lexical description of words in the vocabulary. The acoustic-phonetic mapping is entirely learned via a finite training of a set of utterances. The resulting speech units are essentially acoustic descriptions of linguistically based units as represented in the words occurring in the training set. The pattern recognition-based phonemic approach has been found to have the highest recognition performance so far.

4.0 Main Components of an ASR System

Almost all speech recognition systems use a parametric representation to represent the waveform of a speech utterance. The aim of such a parameterization is: (1) to preserve the main features of speech that can easily identify a sound; (2) to eliminate as much as possible effects produced by communication channels, speaker differences and paralinguistic factors; and (3) to lower the information rate as much as possible for further easier processing, analysis and computation/memory reduction. A wide range of possibilities exists for parametrically representing the speech signal such as: the short-time spectral envelope, Linear Predictive coefficients (LPC), Mel-Frequency Cepstral Coefficients (MFCCs), the short-time energy, zero crossing rates and other related parameters (Figure 2).

To better represent temporal variations in the speech signal, higher-order time derivatives (or simply, delta parameters for first derivatives, delta-delta parameters for second derivatives) of signal measurements are added to the set of static parameters (e.g. MFCCs, LPC, etc.). The combination of dynamic and static features had proved additional discriminability for speech pattern comparison [2] and consequently improved the accuracy of the speech recognition process. Moreover, temporal variations in the speech signal, obtained by applying time derivatives to the speech signal, when combined with the static features mentioned above, had shown additional discriminability for speech pattern comparison [2].

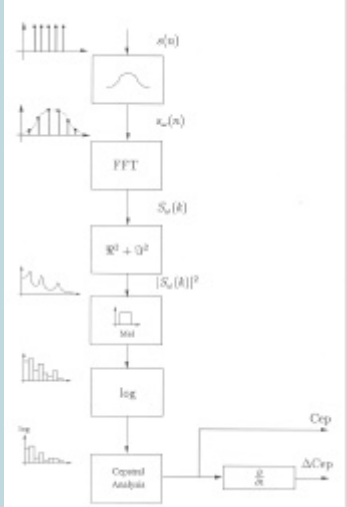

Figure 2: Front end speech parametrisation process.

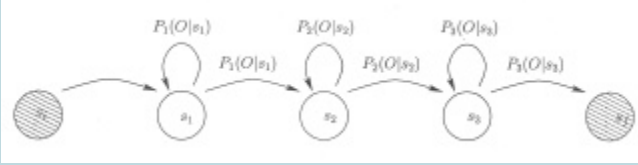

Figure 3: HMMs for context dependent phonemes

Once the feature vectors are formed, they are input to the pattern classification module. This module classifies these vectors into selected linguistic units (words, phonemes, etc.**). This can be achieved by Dynamic Time Warping (DTW), Hidden Markov Models (HMMs), Figure 3 [7], Artificial Neural Networks (ANNs) [8], expert systems [9] and combinations of such techniques. HMM-based systems are currently the most commonly used and most successful approach. This is followed by a word matcher, which takes the phonetic data from the front end and tries to make words out of them on the basis of stored phonetic rules, vocabulary, and syntax rules (i.e. linguistic constraints).

Sentences are formed by the concatenation of the words chosen by the word matcher according to syntax and semantic rules. To accomplish this task, a language model is used to provide a more accurate mechanism for estimating the probability of some word in an utterance given the preceding words. For simple tasks, in which it is only required to recognize a constrained set of phrases, we can use "rule-based" regular or context-free grammars. However, in large vocabulary tasks, "n-gram" (e.g. "bigram" and "trigram") grammars, with given probabilities of occurrence, are most commonly used. The word concatenation is done with an optional silence between words. These concatenated words are then matched to entire sentences which are stored in the lexicon, and the best matched sentence is selected. The sentence level matcher uses constraints imposed by a set of syntactic rules and semantic rules to determine the optimal sequence sentence in the language.

Searching for the best word sequence given the acoustic and language models and a spoken utterance is one of the most computational costs in a large vocabulary ASR system. Whatever the complexity of the acoustic models, the search cost is heavily influenced by the size of the vocabulary (task). Since the number of possible hypotheses grows exponentially with the length of the word sequence, the simple and obvious search strategy going through the whole HMM network is not practical in large-vocabulary ASR systems. In order to limit the exponential search space, heuristical pruning-away hypotheses with low scores techniques are used. The pruning causes the system to make suboptimal decisions while maintaining accuracy in the recognition process.

5.0 Statistical ASR Formulation

Statistical methods are the most dominant approach to speech recognition. Such popularity is due to their simplicity in modeling variations in speech signals using well-known statistical models such as Gaussian distributions, and training the systems using standard machine learning principles. Given an acoustic observation sequence:

$$O = \{o_1, o_2, \ldots, o_T\} \quad (1)$$

the ASR process is performed usually by finding the most likely sequence of acoustic phonetic units, $\hat{W}$, which maximizes the *a-posteriori* probability (MAP) as follows:

$$\hat{W} = \arg max_W \left[P(W|O)\right] \quad (2)$$

Since P(O) is independent of W then

$$\hat{W} = \arg max_W [P(O|W)P(W)] \quad (3)$$

*** Although the word is the natural unit to represent speech in a given language, large-vocabulary ASR systems require the modeling of speech in smaller units than words, i.e., subword units. This is due to the fact that the training of a large number of words is generally impractical. The subword unit used frequently in most existing ASR systems is the phone. There are, however, several variations of subword units. These variations include the context-dependent phone, e.g., biphones and triphones*

where P(O|W) is the probability of observing O when W is uttered.

If the phonetic unit used is the word, P(W) which is generally called the language model, it adds both syntactic and semantic constraints of the language to the recognition task. On the other hand, the MAP decoding can be accomplished by taking into account all possible sequences q of O:

$$\hat{W} = \underset{w,allq}{(\arg max)}\left[\sum_{qi \in q} P(W, q|O)\right] \quad (4)$$

6.0 State-of-the-art ASR Researches

The state-of-the-art ASR technology is the one that is based on HMM technology. That is, most research groups who work in the ASR field are concentrated in attacking the problems associated with HMM-based recognizers. These problems include the complexity of both acoustic and language models, the lexicon size, the searching algorithms and the robustness of such recognizers in adverse conditions. Some of the solutions to the above-mentioned problems that have been proposed over recent years include the use of huge amounts of data and the use of better smoothing techniques in order to refine the acoustic models. Complex language models are used instead of simple bigram and trigram ones. In addition, we use big lexicon and fast searching algorithms. Moreover, we concentrate also on rendering such recognizers more robust in adverse environments (against additive noise, convolutional noise (e.g. telephone speech), uncooperative speakers, rapid speech, spontaneous speech).

7.0 Problems with Existing Approaches to ASR

Almost all existing ASR systems use short-term parameter vectors representing about 10-20 ms of speech. The use of such short segments is inadequate to characterize phonemes in natural speech. In fact, the speech production phenomena of coarticulation, auditory phenomena of forward masking and the linguistic concept of a syllable point to temporal dynamics over an interval of several hundreds of milli-seconds. Thus, the use of short segments disregards all of these important acoustical aspects of speech.

As mentioned above, HMM-based systems are currently the most commonly used and most successful approach for ASR. HMMs became very popular models for ASR because they can deal efficiently with the temporal aspects of speech. In addition, there are powerful training and decoding algorithms that permit efficient training. Also, given their flexible topology, they can be extended to include some phonological or syntactic rules. To train these models, no explicit segmentation is needed, but only a lexical transcription, given a dictionary of phonological models, is necessary for the training of the HMMs.

However, HMMs do not exploit well many acoustical aspects of speech. For example, HMMs treat the very-short-term 10-ms frames of speech as separate information sources, i.e. correlation between successive acoustic vectors is not modeled well. This problem was solved partially by complementing the acoustic features that are used for ASR by their first and second time derivatives and/or using expensive linear discriminative training. Also, the assumption that the state sequences are first-order Markov chains, the prior choice of the model topology and the statistical distributions for each state disregard many acoustical aspects of speech. Besides, practical considerations such as numbers of parameters, the need of thousands of context-dependent phone models to handle coarticulation and the trainability of HMMs limit their implementations.

Another problem with existing ASR systems is the use of the MFCCs, which integrate the short-term spectral envelope of a speech signal over gradually wider intervals following the Mel scale. However, there is no theoretical basis that these coefficients are the optimal ones. In addition, it was found through experiments that these coefficients are highly sensitive to noise.

In addition to these problems, one fundamental problem for continuous speech recognition is the limitation of language models. As mentioned above, in large vocabulary tasks, “n-gram” (e.g. “bigram” and “trigram”) grammars, with given probabilities of occurrence, are most commonly used. n-grams can be estimated from simple frequency counts and stored in a look-up table. However, the problem is that the estimation of such trigrams is very poor due to the fact that many trigrams do not appear in the training data and many others will appear once or twice. To solve this problem, several models have been proposed, such as backing-off models, which are used when there are only one or two occurrences of trigrams in the training data. In such a case, backing-off is applied to replace the trigram probability by a scaled bigram probability. However, such models are very crude.

It must be noted also that all these models ignore hesitations, pauses, false starts, repetitions, etc. Thus, the problem remains unsolved especially for spontaneous speech.

Finally, one of the major drawbacks of existing ASR systems is their robustness against adverse conditions, as mentioned above. Although a lot of research has been conducted by most of the researchers who work on ASR to solve such a problem, it is still an open one, especially with the growing need for applications in wireless environments.

8.0 The Human Way versus the Machine Way

Studies have shown that the performance of existing recognizers are far short of the performance of humans in recognizing speech. This fact motivated several researchers to study the basic principles of human speech recognition (HSR) in an attempt to create artificially intelligent machines that are capable of mimicking humans in recognizing speech. In fact, both HSR and ASR have the same goal; i.e. to get the linguistic message from the signal. However, if we compare HSR manner to most existing ASR systems we find that human auditory perception works differently than current ASR systems. ASR machines use spectral matching techniques, but humans recognize speech with partial recognition of information across frequency [5]. That is, the linguistic message is independently decoded in different frequency subbands; the final decoding decision is based on merging the information from such bands. It was found that such an approach is effective as long as some sub-bands contain relatively uncorrupted information. That is, the information from the possibly corrupted sub-bands does not have to be used to decode the message. Thus, a better understanding of the partial recognition of speech processing in humans is required to get robust ASR. This approach was found effective when used for ASR if some sub-bands contained relatively uncorrupted information [4].

9.0 Future Research & Perspectives

Multilingual automatic speech recognition (ASR) in various acoustic environments is one of the most promising fields of speech communication research. Enormous progress in ASR research was made in the past 40 years. However, the desired goal of a machine which can understand a task-independent expression uttered by all speakers using various languages in different environments is still far from reality. Current research is now focused upon statistical methods. Improving the performance of ASR systems that are used to recognize spontaneous speech in adverse environments is still an open problem. This demand increases especially with the increase of the use of these systems in telephone applications.

Enhancing the performance of such recognizers in adverse environments can be achieved by using other auditory-based strategies instead of the Mel approximation in order to get more robust features that can be used for the recognition of both clean and telephone speech.

The recognition of spontaneous speech can be improved by taking into consideration the effects of the filled pauses while performing the recognition process by: (1) either omitting such pauses or by considering them as words to be added to the dictionary of the ASR system, (2) recognizing hesitations and restarts, (3) improving the model accuracy at both the acoustic level and at the language model level and (4) increasing the amount of training data and the lexicon size. This could reduce the error rate without increasing the search complexity.

Finally, we believe that a better understanding of the properties of human auditory perception that are relevant for decoding the speech signal and are likely to improve the performance of ASR in different environments is necessary for improving the performance of the existing recognizers. Also, using longer acoustic units (for example, syllables) instead of using short-term speech segments followed by post-processing techniques or using dynamic features is promising for the evolution of ASR. Moreover, rich prosodic cues (e.g., fundamental frequency (F0), energy, duration, etc.) that permit successful understanding, which are ignored by state-of-the-art ASR systems, must be considered for better performance. Also, the use of language-independent acoustic models and variable n-gram language models will enhance the performance further. Finally, we recommend strongly to benefit

from the results of the research of the HSR field by using a hybrid system that is not based only on statistical methods but also on speech communication knowledge. Using such a system could solve almost all the problems of ASR in the existing systems.

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Hesham Tolba received a B.Sc. degree in electrical engineering and a M.Sc. degree in digital communications from Alexandria University in Egypt. He received his Ph.D. in Telecommunications from the INRS-Telecommunications, Quebec University, Québec, Canada. In 2000, he joined the INRS-Telecommunications as a professor in the speech communication group. He was previously a professor in the electrical engineering department at Alexandria University, Egypt. His current research interests include speech Processing, enhancement, synthesis and Recognition.

Douglas O'Shaughnessy has been a professor at INRS-Telecommunications (University of Quebec) in Montreal, Canada, since 1977. His interests include automatic speech synthesis, analysis, coding and recognition. He has been an Associate Editor for the Journal of the Acoustical Society of America since 1998, and will be the General Chair of the 2004 International Conference on Acoustics, Speech and Signal Processing (ICASSP) in Montreal, Canada.

The 2001 Canadian Engineers' Awards

May 26, 2001
New Brunswick Community College,
St. Andrews-by-the-Sea, N.B.

CONSEIL CANADIEN DES INGÉNIEURS
CANADIAN COUNCIL OF PROFESSIONAL ENGINEERS

Presented annually by CCPE since 1972, the Canadian Engineers' Awards recognize outstanding individual Canadian engineers, engineering projects, and teams of engineers. In 2001, CCPE will present its inaugural Award for the Support of Women in the Engineering Profession.

The theme for the 2001 Awards is Great Canadian Engineers: Connecting People, Connecting Worlds.

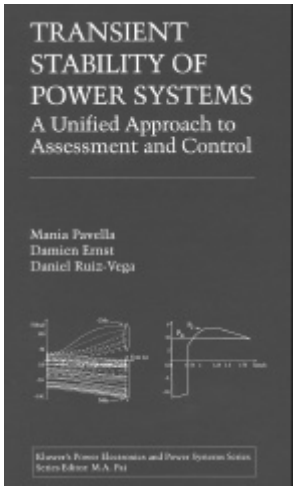
The 2001 Award recipients include an engineer whose goal is to make engineering an attractive career choice for Native Canadians, an inventor who is helping hard of hearing people to communicate, one of Chatelaine Magazine's Top 15 Canadian Women to Watch, an expert in highway safety who got his start as a teacher in a one-room school house, a university professor who is working hard to open the doors of engineering to women, one of Canada's leading researchers in oil sands technology, and a teacher who goes the extra mile to help students understand difficult concepts.

Photo features (from left to right) Noel Cleland, President of CCPE, and Dr. Charles Andrew Laszlo, C.M., O.B.C., P.Eng. winner of the Gold Medal Award for exceptional individual achievement and distinction in a field of engineering;

The 2001 winners of the Canadian Engineers' Awards are:

- **Don B. MacEwen**, P.Eng. - Medal for Distinction in Engineering Education for exemplary contribution to engineering teaching at a Canadian University,
- **Marc Lalande**, ing. - Meritorious Service Award for Community Service for exemplary voluntary contribution to a community organization or humanitarian endeavour,
- **Dr. Janet A.W. Elliott**, P. Eng. - Young Engineer Achievement Award for outstanding contribution in a field of engineering by an engineer 35 years of age or younger,
- **Dr. Frank R. Wilson**, P. Eng. - Meritorious Service Award for Professional Service for outstanding contribution to a professional, consulting or technical engineering association or society in Canada,
- **Dr. Nancy Mathis**, P. Eng. and **Marie Bernard**, ing. - Award for the Support of Women in the Engineering Profession for exemplary actions and contributions that open doors for women to successfully enter the engineering profession (Presented for the first time in 2001),
- **Dr. Charles Andrew Laszlo**, C.M., O.B.C., P.Eng. - Gold Medal Award for exceptional individual achievement and distinction in a field of engineering.

Transient Stability of Power Systems - A Unified Approach to Assessment and Control



by Mania Pavella, Damien Ernst and Daniel Ruiz-Vega

Kluwer's Power Electronics and Power Systems Series
ISBN 0-7923-7963-2
Published in 2000, 237 pages
by Kluwer Academic Publishers

Book reviewed by *Vijay K. Sood*
Hydro-Quebec, Varennes, QC

This book comes at an opportune moment since new dynamic security assessment functions are now being incorporated into energy control centers in many utilities. This monograph describes a direct method based on a generalised **One Machine Infinite Bus** (OMIB) equivalent.

The book has 7 chapters, 2 appendices and the subject matter is covered in a compact 237 pages. This is an excellent book on the topic, and is destined to join the rank of classics. The book is professionally written by the authors who are led by a a recognized authority on the subject. In addition, the book is professionally type-set (by Mrs. Lecomte, I imagine) and the english usage is excellent. For a reviewer these facts made the task of reading and comprehending a difficult subject that much easier. Each chapter commences with a brief 'Objectives of the Chapter' and finishes with a Summary of the chapter.

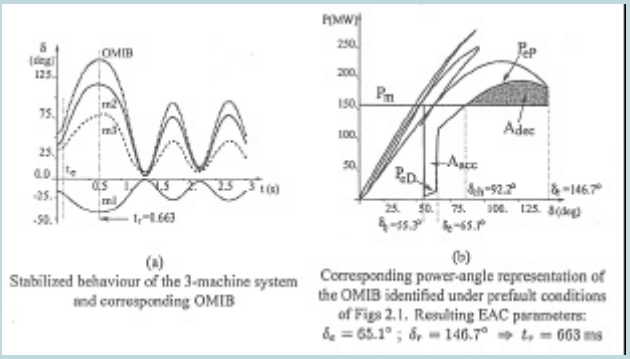


Figure 1: Swing curves and OMIB P-d representation of the 3-machine system. Contingency Nr 2; t_e = 92 ms.

The authors explain early on for the need of another book on Transient Stability: "The nonlinear character of transient stability, its fast evolution and its disastrous practical implications make it one of the most important and at the same time most problematic issues to assess and even more to control, especially today, with the emerging deregulation practises of the electric sector in many countries". The present monograph is devoted to a comprehensive and unified approach to Transient Stability Assessment and Control (TSA&C) called **SIngle Machine Equivalent** (SIME) method which is based on the Ph.D. thesis of Dr. Y. Zhang, a former student of Mania Pavella.

Chapter 1 provides the historical background to the main topic of Transient Stability (TS) and the two methods - direct and automatic learning - for solving the problem of TS. The automatic learning methods are only briefly described as they do not form the focus of the monograph. The direct methods are described in more detail to provide an understanding for the SIME method which is referred to as a hybrid direct method. The foundations of the OMIB equivalent are laid out in the observation that in a multi-machine system, the loss of synchronism originates from the separation of its machines into two groups; these groups are first replaced by single machines and then eventually by an OMIB equivalent.

An introduction to the SIME method is provided in Chapter 2. The OMIB is viewed as a transformation of the multidimensional multi-machine dynamic equations into a single dynamic equation and is based on the classical equal-area criterion (EAC). Appendix A provides information on the equal area criterion (EAC) for assessing TS in a simple and comprehensive way. Illustrations are provided by using the Hydro-Quebec system as an example.

Chapter 3 provides the core of the SIME methodology. The use SIME calculated margins provides suitable performance indicators for sensitivity analysis to be carried out.

Chapter 4 derives a systematic procedure for computing stability limits and describes a variety of techniques for screening cases and selecting the constraining cases. Procedures are developed for stabilizing the constraining cases, and paves the way towards the use of on-line TSA techniques.

In Chapter 5, the on-line techniques elaborated in Chapter 4 are organized in a software package. This software package can be either used alone or interfaced with an OPF program to broaden its possibilities. Ways of integrating this package within an EMS environment to perform on-line congestion management calculations are also explored.

Chapter 6 deals with the next generation on-line TSA techniques for providing emergency control to prevent instability and separation of the system.

The book contains two Appendices. Appendix A provides a refresher on the classical Equal Area Criterion for assessing TS.

Appendix B provides data of the simulated systems used in the book such as the 3 machine test system model adapted from the EPRI system. Other systems used are the Hydro Quebec and Brazilian test systems.

This is a book that will become a classic in its own right with time. For those who work in the domain of TSA, it is a must-read monogram. The book is professionally edited. I would have preferred to have the references at the end of each chapter rather than at the end of the book; but that is a personal choice. The graphics and figures are carefully drawn and well presented; the one figure that I had some exception to is Figure 1.6 on page 25 which has been taken from an earlier reference. The use of practical examples with the Hydro-Quebec and Brazilian systems are also appropriate for the subject. The book will be useful for graduate researchers and practicing engineers alike.

****

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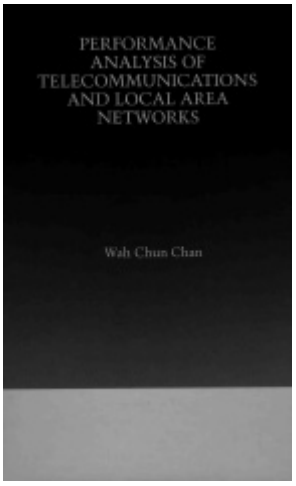
Performance Analysis of Telecommunication and Local Area Networks



By Wsh Chun Chan

Published by Kluwer Academic Publishers

Norwell, Massachusetts, USA

466 pages, ISDN 0-7923-7701-x

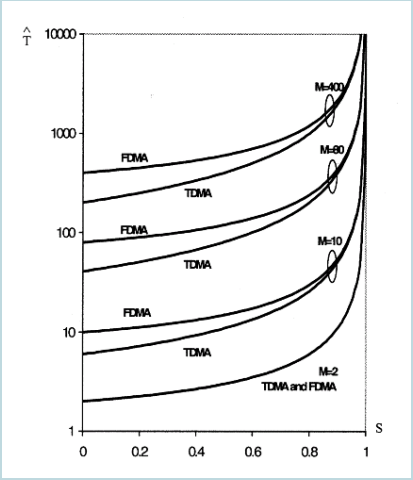
Book reviewed by Shaowen Song and Zongsen Wu
Physics and Computing Department,
Wilfrid Laurier University, Waterloo, ON

The book presents the basic concepts and fundamental methods of performance analysis in telecommunications and local area networks. It is designed to provide an understanding of the fundamental principles of teletraffic engineering. Emphasis is placed on the modeling techniques using queuing theory for the public-switched telephone network and local area networks. There have been several books on the performance analysis of data networks or computer networks, but most of them are at a higher mathematical level. This book attempts to present the essentials of queueing theory at a level that undergraduate students and practice engineers can understand.

The book is divided into ten chapters, and is 466 pages long. In Chapters 1 to 6, telecommunication networks are analyzed, and in the remaining chapters local area networks are discussed.

Chapter 1 covers a brief historical overview of the development of telecommunications. After defining some important terms needed for the description of telecommunication systems, the author describes several typical telecommunication networks such as the public telephone network, the ARPA network for computer communications, the SITA network for worldwide airline reservation services, and the Ethernet for local area networks. In addition, this chapter introduces the concepts of time congestion and call congestion, the peakedness factor as a basic parameter for the characterization of input traffic in a telecommunication network, and the busy hour traffic.

Chapter 2 provides the background knowledge of transmission system for telecommunication networks. The methods for subscriber loop design, digital transmission, and techniques for signal multiplexing are introduced. Discussions on the differences, advantages, and drawbacks of these methods are also presented in reasonable detail.



Average normalized delay versus throughput for TDMA and FDMA with the number of stations, M, as a parameter (figure 7-4 of the book on page 314)

In Chapter 3, switching systems, switching techniques and methods of calculation of congestion are introduced. The author uses network graphs and channel graphs to simplify the calculation. Both the blocking and nonblocking networks are investigated.

Chapter 4 deals with a detailed study of the modeling techniques of traffic flows. The author points out the important properties of the Poisson traffic flow and the Markov property of the exponential service time distribution. Using the methods of Markof chain and imbedded Markof chain, the M/M/1 queue, the M/G/1 queue, and the GI/M/1 queue are investigated in detail.

In Chapter 5, Erlang loss and Erlang delay systems as the central models for design of telephone systems in North America are investigated. The author derives two formulas for the calculation of congestion in telephone systems, using the result obtained from the birth and death process. These are known as the Erlang B and the Erlang C formulas.

Chapter 6 discusses the Engset loss and Engset delay systems with quasi-random inputs. These systems form the primary models for the design of telephone systems in Europe. The author determines Engset loss and Engset delay formulas for the calculation of congestion in telephone systems by results obtained from the birth and death process.

Starting from Chapter 7, local area networks are introduced. Three multiaccess techniques for controlling the access to the networks: fixed, random and demand are adequately covered in this chapter. Then the author calculates the average transfer delay and throughput for all three multiaccess methods.

Chapter 8 deals with the basic features and the two models of operations in polling networks and their configurations. In addition, the author examines the polling cycle and the average waiting time, and also develops the expression for the average waiting time of the packet for an exhaustive network.

Chapter 9 presents the performances of token ring networks in three operations: multiple-token, single-token and single packet, and discusses the average transfer delay for the three operations.

Finally, Chapter 10 investigates the performance of slotted ALOHA networks for cases of Poisson input and a finite number of stations. Moreover, the author discusses an analytical technique for the investigation of more complicated protocols.

In summary, the book is easy to read and understand for undergraduate students and practical engineers, because the book uses the essentials of queueing theory instead of a higher level of mathematics. Also, this book covers adequately all aspects of networks in telecommunication and local area that fits the needs by most engineers and scientists in the field. We feel that with some supplementary materials the book can also be a good textbook for graduate students, and certainly the book is useful for practice engineers for self-study as well because of emphasis on practical applications. We found that the summary at the end of each chapter is quite useful to readers, and it is systematic to leave the derivations of tedious mathematics in the appendices for Chapters 4 and 10. One minor suggestion is that more effort is required on text formatting and illustrations. The book can become more attractive with exquisite text formatting and better illustrations.

****

The CR Editor acknowledges the support of Mr. Alex Greene (email: Alex.Greene@wkap.com), Kluwer Academic Publishers for his support of this Book Review.

Electricity Deregulation:

Sir:

The article "Electricity Deregulation: Doubts Brought On by the California Debacle" by Maurice Huneault (IEEE Canadian Review Spring 2001) contained an excellent discussion of the economic and technical factors. However, it omitted to include two very important factors that should play an important role in such analysis. These concern environmental factors. For example, the cheapest method of generating electricity other than hydro is by burning coal at present because the price of coal is discounted because of its serious negative environmental effects. To generate a kilowatt of electricity releases considerably more carbon dioxide than using natural gas and this factor can be as high as two depending on the quality of the coal and the technology used to burn it. Coal will never compete with natural gas on this basis because it is an unsaturated hydrocarbon. Moreover, the combustion of coal releases significant amounts of mercury that are vaporized in the stack gases but condense as it disperses producing a halo region where it will precipitate. For example, the coal burning power plants at Wabamin in Alberta have contaminated the adjacent lake to such an extent that it is unwise to eat fish caught there. Stack gas scrubbers are effective for sulphur dioxide and some other toxic emissions. Most coals contain small but non-trivial amounts of uranium and other heavy metals that are concentrated in the ash. This ash is returned to the coal pit or a disposal pit where the heavy metals leach into the ground water system.

At present, one of the few means of generating electricity available to us without the imposition of rationing is to build more nuclear plants. These plants are capital intensive although the Candu reactors generate power at very attractive and economic rates depending on the amortized costs used to estimate their decommissioning. Commercial interests favour lower capital costs and higher operating costs because of the cost of borrowing capital and the delay in obtaining a return. Public opinion on this subject certainly does not favour this approach during the transition to a higher reliance on renewable sources of energy despite its advantages.

The Arctic regions of Canada are already experiencing significant climate warming and there are many indicators of this warming elsewhere in our country because of our higher latitude location. We must develop a national strategy for lower our release of greenhouse gases and this means a national energy strategy. This above comments only serve to demonstrate that their is no free lunch. Cheap energy creates high levels of pollution for which the price to be paid is delayed for another generation with higher net costs. A sound energy policy does not ignore the future costs of current decisions as we are doing today.

Deregulation is most effective from an economic viewpoint where the majority of the energy generated is from hydro sources as Table 1 demonstrates. Even hydro is not free from environmental effects as the Quebec experience with the James Bay project demonstrates. Large relatively shallow areas behind dams in the Canadian Shield lead to the release of large quantities of mercury that has contaminated the aquatic resources used by the aboriginals as food sources.

The above discussion demonstrates that it is extremely difficult for technological humans to live in harmony with nature. Most ancient civilizations failed because they failed to respect their environment and use it sustainably. When will we learn?

Harvey Buckmaster
Victoria, BC

Are you riding a dead horse?

The tribal wisdom of the Dakota Indians, passed on from generation to generation, says that when you discover you're riding a dead horse, the best strategy is to dismount. In modern corporate and governmental America, however, a whole range of advanced modern strategies are often employed, such as:

- Buying a stronger whip,
- Changing riders,
- Threatening the horse with termination,
- Appointing a committee to study the horse,
- Sending a Congressional delegation to see how other countries ride dead horses,
- Lowering standards so that dead horses can be included,
- Reclassifying the horse as "living impaired,"
- Hiring contractors to ride the dead horse,
- Harnessing several dead horses together to increase their speed and power,
- Providing additional funding and/or training to increase a dead horse's performance,
- Doing a productivity study to see if a lighter rider would improve a dead horse's performance,
- Declaring that, as the dead horse does not have to be fed, it is less costly, carries lower overhead, and therefore contributes substantially more to the bottom line than do some other horses, particularly those classified as "not-quite-dead-yet,"
- Re-writing the minimum performance requirements for all horses,
- Promoting the dead horse to a supervisory position, and
- Repetitively re-assess the horse's performance until it rises from the dead...

Sent in by Satya P. Roy
Cedar Rapids, Il, USA

Subject: HELP line

Dear Tech Support,

Last year I upgraded from Boyfriend 5.0 to Husband 1.0 and noticed that the new program began making unexpected changes to the accounting modules, limiting access to flower and jewelry applications that had operated flawlessly under Boyfriend 5.0.

In addition, Husband 1.0 uninstalled many other valuable programs, such as Hot-sex 1.0 and Romance 9.9 but installed undesirable programs such as NFL 5.0, NBA 3.0, Cricket 6.1. Every so often WorldCup 4.3 would invade the system but would mysteriously disappear after a while.

Conversation 8.0 no longer runs and HouseCleaning 2.6 simply crashes the system. I've tried running Nagging 5.3 to fix these problems, but to no avail.

Desperate Wife.

Dear Desperate Wife,

Keep in mind, Boyfriend 5.0 is an entertainment package, while Husband 1.0 is an operating system. Try to enter the command: C:/ I THOUGHT YOU LOVED ME and install Tears 6.2. Husband 1.0 should then automatically run the applications: Guilty 3.0 and Flowers 7.0.

But remember, overuse can cause Husband 1.0 to default to Grumpy Silence 2.5, Happyhour 7.0 or Beer 6.1. Beer 6.1 is a very bad program that will create "Snoring Loudly" wave files.

DO NOT install MotherInLaw 1.0 or reinstall another Boyfriend program. These are not supported applications and will crash Husband 1.0. In summary, Husband 1.0 is a great program, but it does have limited memory and cannot learn new applications quickly.

Consider buying additional software to improve performance. I personally recommend HotFood 3.0, Lingerie 5.3 and Keep-a-nice-body 10.1.

Tech Support.

Sent in by Anne McLoud
Markham, ON

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CCECE 2001 - Technology for the Millennium

Canadian Conference on Electrical and Computer Engineering
May 13-16, 2001 Delta Chelsea Hotel
Downtown Toronto, Ontario, Canada

Report on the Fourteenth IEEE Canadian Conference on Electrical & Computer Engineering

1.0 Technical Program

The conference theme "Technology for the Millennium" was evident in the excellent technical program representing the latest developments in electrical and computer engineering technologies. The program included thirty oral and two poster paper sessions. The technical sessions during the three days included 240 papers authored and co-authored by 629 engineers, professors and students from 29 countries around the world. The oral sessions covered modern developments on various topics, such as, intelligent systems, multimedia, computational intelligence, image processing, biomedical applications, digital design, software systems, signal processing, networks, communication and power systems.

2.0 Plenary Sessions

The morning plenary sessions were held to present an overview of the current state of technology and visions for future developments in some of the fast-paced fields. The Monday plenary session speaker Prof. Simon Haykin of McMaster University presented the current state of research and his future visions on adaptive and learning systems. The Tuesday plenary speaker Prof. Anastasios Venetsanopoulos of the University of Toronto presented an overview of current research activities in multimedia signal processing and their societal, economic and technical impact on future developments. Dr. Richard Normandin of the National Research Council of Canada, the plenary speaker on Wednesday morning, presented research activities related to device technology convergence in photonics.

(From left to right) Professor S.Hakim, H.Karmaker and B.Dony at the Plenary session.

3.0 Tutorial sessions

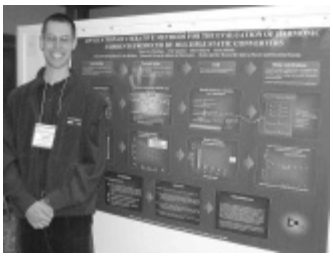
Two tutorial sessions were held on Sunday afternoon. The first tutorial session was conducted by Prof. Wael Badawy of the University of Calgary on "MPEG-4 for Multimedia Streaming". The second tutorial session was conducted by Prof. Armin Eberlein of the University of Calgary on "How to Know What to Build Before You Develop Your System."

4.0 Student Paper Award

On Tuesday, a special student awards luncheon honoured the best student papers of the conference. The guest speaker Dr. Doug Barber of Gennum Corporation inspired the students and delegates with a keynote speech on "Living and Working in a Knowledge-Based Economy". Dr. Barber discussed the evolution of civilization and the engineers' contributions and emphasized the future role of engineers in the present knowledge based economy.

Dr. Barber awarded the paper prize certificates to the best three student papers judged by the technical program committee.

- The first paper certificate was awarded to Paper MA4.1 (060) title "Nonlinear channel estimation using correlation properties of PN sequences", by Xavier N. Fernando and Abu B. Sesay of TRLabs and the University of Calgary,
- The second paper certificate was awarded to Paper TA3.2 (311) title "Encoding of color still pictures wavelet transform and vector quantization" by Shin-Ichi Kadono, Osarm Tahara And Noriyoshi Okamoto of the Kanto Gakuin University, Japan,



Poster session paper presentation by Dr. M. Montigny

Student paper award presentation with J. Bradley (fourth from left) and guest speaker D. Barber (fifth from left)

- The third student paper award winner was Paper MP 21 (313) title "Design of a multilevel DRAM with adjustable cell capacity" by Yunan Xiang, Bruce F. Cockburn, Duncan G. Elliott of the University of Alberta.

5.0 Exhibitors

Four exhibitors exhibited their products at the conference. They were McGraw-Hill, Bell Sympatico, Niagara College and IEEE Gold. The poster sessions and networking breaks were held in the exhibit area.

6.0 Receptions and Banquets

A cocktail reception was held on Sunday evening and the conference chair Dr. Haran Karmaker of General Electric Company welcomed the delegates and their companions. The welcome messages from Right Honourable Jean Chretien, the Prime Minister of Canada, Honourable Michael Harris, the Premier of Ontario and the Toronto City Mayor Mel Lastman were read by Dr. Karmaker.

The keynote speaker at the IEEE Canada Awards Banquet was Dr. Wallace Read. The keynote speech title "Engineers Don't Grow on Trees" highlighted the engineers' responsibilities in the new millennium by two key words "Teamwork" and "Trust."

The keynote speaker at the IEEE Canada Awards Banquet was Dr. Wallace Read.

Conference organizing committee (from left): Sean Dunne, Bob Hanna, Pelle Westlind, Cathie Lowell, Bob Dony, Celia Desmond, Haran Karmaker, Kostas Plataniotis, Kash Husain, Janet Bradley, and Bob Hudyma.

Niagara College Student Volunteers with Student Activities Chairperson

(Front L-R: Marc McGowan, Mike Matheson,

Back L-R: Gerrit Hammond, Janet Bradley, Rebecca Holden, Jeff (Green Hair) Brown and Melinda Morningstar).

7.0 Conference Proceedings

Those who could not attend the conference have opportunity to purchase the CD-ROM and the paper proceedings. For ordering information, please visit the conference web site http://www.ieee.ca/~cece01/ or contact Cathie Lowell at (905) 628-9554 or e-mail c.lowell@ieee.org.

8.0 CCECE 2002

CCECE 2002 will be held in Hotel Fort Garry, Winnipeg, Manitoba on May 12-15, 2002. For information, please visit the web site ewh.ieee.org/soc/cece02/.

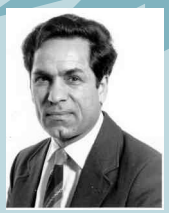
Region 7: Recently elected Senior Members of the IEEE

Section	Name	Technical Affiliation
Kitchener-Waterloo	Ibrahim, Malik R	Power Engineering Society
Kitchener-Waterloo	Zhuang, Weihua	Communicatuins Society Vehicular Technology Society
Montreal	Shayan, Yousef	Communications Society
Montreal	Le, Di-Luan	Instrumentation & Measurement Society and Microwave Theory & Techniques
N. Brunswick	Hudgins, Bernard S	Engineering in Medicine and Biology Society
N. Brunswick	Lorenzo-Ginori, Juan Valentin	
Ottawa	Al-Dhaher, Abdul Hafid	
Ottawa	Lethbridge, Timothy C	Computer Society
Ottawa	Yang, Oliver W	Electromagnetic Compatibility Society and Communications Society
Ottawa	Pham, Tuan	Systems, Man, and Cybernetics Society
Ottawa	Roddick, Laird H	Computer Society
Saint Maurice	Agbossou, Kodjo	
Southern Alberta	Prystajecky, Walter	Power Engineering Society
Southern Alberta	Sesay, Abu-Bakarr	Circuit and Systems Society, Communications Society, Education Society, Information Theory Society, Signal Processing Society & Vehicular Technology Society
Toronto	Botchkarev, Alexei	Computer Society
Toronto	Turner, John E	Industry Applications Society
Vancouver	Gough, William A.G	Control Systems Society and Industry Applications Society
Vancouver	Kuras, Kazik	Power Engineering Society
Vancouver	Marti, Jose R	Power Engineering Society
Winnipeg	McDermid, William J	Dielectrics and Electrical Insulation Society Instrumentation & Measurement Society and Power Engineering Society

IEEE Canada Awards - 2001

McNaughton Gold Medal - 2001

Recipient: Dr. Om Malik



Citation for award: For Outstanding contributions in research and development of digital and adaptive controllers for power systems and to engineering education.

Biography:

Dr. Malik graduated from Delhi, India in 1952. After working for 9 years in electric utilities, he returned to academia and obtained his Master's degree from Roorkee University, India, in 1962, Ph.D. degree from London University, and the DIC from Imperial College, London, in 1965.

Dr. Malik has done pioneering work over the past 30 years in the development of digital controllers for application in electric power systems. His research group was the first to propose and investigate digital/adaptive controllers for on-line real time applications to improve the operation of electric power generators. In addition, he has done extensive work in the area of power systems protection, particularly digital and artificial intelligence based protection techniques.

He was teaching and doing research from 1966 to 1997, and is currently a Professor Emeritus at the University of Calgary. Dr. Malik has been extremely active with 31 Ph.D. and 17 M.Sc. students having completed their thesis under his supervision. He has published over 400 technical papers in various international journals and conferences.

Dr. Malik has performed extensive service over the years for various technical societies, such as IEEE, CEA, APPEGA, IEE, IFAC, COPIMERA, etc. He has received many honours, medals, and awards. Om Malik is a Fellow of the EIC, a Fellow of the IEE, and a Life Fellow of the IEEE.

The McNaughton Gold Medal is IEEE Canada's highest honor.

Dr. Om Malik received his award from Celia Desmond (right), President of IEEE Canada at the recent CCECE 2001 meeting in Toronto.

Fessenden Silver Medal

Norman Toms

Outstanding Engineer Award

Ibrahim Gedeon

Outstanding Engineering Educator Award

Roy Billinton

Three Canada Council Merit Awards were presented by Celia Desmond, president of IEEE Canada:

Blythe Broughton Central Canada Council Merit Award

Ashfaq (Kash) Husain

Eastern Canada Council Merit Award

Glen Rockett

Wallace S. Read Service Award

Ferial El-Hawary

L'Académie canadienne du génie

The Canadian Academy of Engineering

1 June 2001: President Micheline Bouchard, FCAE, today formally welcomed 29 new fellows into the Canadian Academy of Engineering (CAE). The ceremony took place in Calgary, Alberta, in conjunction with the Academy's Annual General Meeting, at the Petro-Canada Centre there. "This is the largest group of new inductees admitted since the Academy was established in 1987" said Mme. Bouchard "and this increase in the number of inductees represents a major step forward in recognizing some of the most innovative engineers in Canada".

CITATIONS - NEW CAE INDUCTEES

1. JEAN BÉLANGER

Jean Bélanger est un ingénieur spécialisé en électronique et président fondateur de Opal-RT. Cette PME de 40 personnes, créée en 1997, commercialise de puissants outils de simulation numérique en temps réel pour les industries de l'automobile, de l'aérospatiale, de la robotique et les utilités électriques. Jean Bélanger a aussi joué un rôle clé dans la conception et construction des lignes à 735 kV de l'Hydro-Québec provenant de la Baie James ainsi que dans le développement de puissants simulateurs de réseaux électriques et de leurs logiciels.

2. PRAKASH BHARTIA

Prakash Bhartia, Director General at Defence Research Establishment Ottawa, has 30 years of exceptional contributions to electromagnetic systems, including microstrip antennas, transmission lines, microwave and millimeter wave components and systems. They are embodied in 8 books and over 150 papers, as well as several patents, which are used in industry and universities around the world. Dr. Bhartia has led the Dept. of National Defence efforts in navigation systems, radar and space technologies, many of which are in current usage in the Canadian Forces. He has demonstrated outstanding scientific creativity, productivity and leadership, as well as management skills.

3. HOWARD CARD

Howard Card, Distinguished Professor of Electrical and Computer Engineering at University of Manitoba, has made outstanding contributions to the related fields of pattern recognition, microelectronics and digital signal processing, specifically through research and development of novel hardware and software for artificial neural networks and their applications. He has demonstrated great leadership in training highly-qualified personnel, primarily undergraduate and graduate students, in these areas.

4. DAVID COLLETT

David Collett has spent his entire professional career at Newfoundland and Labrador Hydro, where he is presently Executive Vice President, Production. He is recognized for his engineering leadership on the development of the massive Churchill River Developments (Upper and Lower) as well as other generation and transmission projects. He has shown similar leadership in his activities for the engineering profession.

5. FRANÇOIS GONTHIER

François Gonthier, Président fondateur, ITF Technologies Optiques, est ingénieur physicien et un inventeur-innovateur-entrepreneur peu ordinaire. À 33 ans, en janvier 1997, il créait ITF Technologies inc. pour exploiter ses premières inventions de coupleurs multifibres pour télécommunications par fibre optique. ITF s'affiche déjà comme l'une des entreprises les plus dynamiques au Canada; avec 95 M$ d'investissements privés à ce jour, des ventes de 10 M$, déjà 600 employés, et une valeur au marché de plus d'un milliard $. L'ingénieur Gonthier est un inventeur prolifique (15 brevets à ce jour et plusieurs autres à venir) et l'auteur de 65 publications savantes, la plupart avant son entrée en affaires.

6. DAVID PARNAS

David Parnas, Director of the Software Engineering Program at McMaster University, has made outstanding contributions to the science and art of software engineering through the development of basic concepts in software design, software specification methods and the methodology for inspection of safety-critical software. He has provided visionary leadership in developing educational programmes for computing and software engineering, and in defining the professional role of software engineering.

7. EMIL PETRIU

Emil Petriu is Professor of Electrical and Computer Engineering at the University of Ottawa and Director of the new School of Information Technology and Engineering. He has invented an absolute position measurement method using pseudo-random encoding. The resulting very-high resolution serves in 3D model-based object recognition using computer vision, tactile robot-sensing, or structured light. He is a dedicated teacher and a prolific author.

8. WALLACE READ

Wallace Read, President of Read Management Advisory Services, has for fifty years continuously provided outstanding leadership in the electric power sector in Newfoundland, in Canada and internationally. He oversaw the engineering and construction of the great system expansion of Newfoundland from the mid-1960's to the mid-1980's. He became the first full-time President of the Canadian Electricity Association providing innovative leadership and serving as the industry's national spokesperson for a decade. Always generous with his time in service to his profession and his community, he has been recognized with many awards in both domains.

9. MOHAMAD SAWAN

Mohamad Sawan, Professeur titulaire à l'École Polytechnique, est un ingénieur électronicien reconnu mondialement pour son rôle de pionnier en dispositifs médicaux intelligents (DMI). Il a su équilibrer sa carrière avec rigueur, étant tour à tour enseignant, formateur de spécialistes de l'électronique et du biomédical, chercheur, inventeur, innovateur, entrepreneur, rassembleur et agent de transfert de ses nouvelles technologies vers l'industrie canadienne. Il vient de se voir octroyer 8 M$ pour une plateforme technologique lui permettant d'oeuvrer plus efficacement avec d'éminents chercheurs dans 8 spécialités différentes de la médecine. Il est l'auteur de 4 brevets, de quelque 200 articles scientifiques, de nombreux chapitres de livres, etc.

10. ANASTASIOS VENETSANOPOULOS

Anastasios Venetsanopoulos, Professor of Electrical and Computer Engineering, University of Toronto, has made outstanding contributions to the design and implementation of communication systems, digital filters and multimedia systems and to university teaching, inspiring lectures and seminars, for more than 140 short courses to industry and government laboratories, and for 272 scholarly addresses. He has also made significant contributions to research, as co-author and contributor to a very large number of excellent books (28) and papers in journals and scientific conferences (667), and to the engineering profession and the society at large.

11. RABAB WARD

Ms. Rabab Ward, Director of the Centre for Integrated Computer Systems Research at UBC, is a leader in the application of digital signal processing theory to cable and high-definition television, medical images, restoration of astronomical images, and extraction of an infant's distress level from his/her cry signal. Being a highly accomplished researcher and a prolific inventor, she has an impressive list of publications and patents, and her work is used in various companies and laboratories worldwide. Examples include her non-intrusive method for measuring the picture quality in cable TV systems, the non-interfering video system used by the aqua-culture industry, and the fluorescence microscope system used by cell-biology researchers.

12. SONGNIAN ZHOU

Songnian Zhou, CEO & Chairman of Platform Computing Corp, is a software engineer of remarkable creativity and a successful entrepreneur. His pioneering research at Berkeley led the foundation of the Internet "postal office". He later broke ground in computing resource management in large distributed computing systems. His new system, Utopia, was adopted by Northern Telecom on over 1,000 computers with 30-40% productivity increase. In 1992 he co-founded Platform Computing with no venture capital funding and built it into a leading software company with 300 people and sales of $ 60M in more than 50 countries.

Université du Québec
École de technologie supérieure

Call for Papers ELECTRIMACS 2002

7th International Conference on Modeling and Simulation of Electric Machines, Converters and Systems (ELECTRIMACS 2002)

August 18-21, 2002, École de technologie supérieure, Montreal, Canada

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AIMS AND TOPICS: Traditionally, **ELECTRIMACS** conferences aim to establish a high-standard international forum in order to exchange information and new results of research in modeling and simulation, in various fields of electrical engineering.

APPLICATION FIELDS: Electrical machines and transformers, electronic power converters, electrical drives, applications of new materials (power semiconductors, magnetics, superconductors, etc.), consumer and other electrical products, emerging electric technologies. Recent development of complex systems such as distributed power system, electric vehicles and traction, electrothermal systems, spatial, airborne, and naval applications are encouraged.

MODELING AND SIMULATION: Topics include, but are not limited to:

Methodological Aspects:

- Numerical methods;
- Analytic and hybrid methods;
- Specific control methods;
- System identification methods;
- Fuzzy and neural methods;
- Applications of general purpose or dedicated software;
- Dedicated signal processing;
- Model based measurements.

Specific problems:

- Thermal problems;
- Electromagnetic problems;
- Electromechanical interactions;
- Electromagnetic compatibility;
- Optimization;
- Power quality evaluation;
- Integrated design;
- Model validation and verification.

SUBMISSION OF ABSTRACTS: Please send the General Secretary a 500 words abstract written in French or English. The following information must appear on the first page of your document:

- Paper title;
- Author's name and affiliation (please identify corresponding author);
- Mailing address;
- Telephone number, fax number, e-mail address;
- Conference topic most appropriate for the suggested paper.

Submission address:

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École de technologie supérieure
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Telephone: (514) 396-8898
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Author's Schedule:

Paper abstracts:	December 7, 2001
Notification of acceptance:	February 28, 2002
Full paper due:	May 31, 2002

ELECTRIMACS 2002 Website: www.electrimacs2002.com