1 Background Data

Name: Guy Kember
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Birthdate: 15 April, 1959
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2 Education

University Of Western Ontario (UWO) 1979-1983 HBSc Applied Maths 1983-1984 M.Sc. Applied Maths 1984-1988 Ph.D. Applied Maths Scholarhip Award 1985-1987 NSERC PGS II Teaching Experience Teaching Assistant, University of Western Ontario, 1981-1988. Teaching Assistant, OCIAM, 1990-1991.

3 Career

1. 2003-present: Full Professor, department of Engineering Mathematics, Dalhousie University.

2. 1998-2002: Associate Professor with tenure, department of Engineering Mathematics, Dalhousie University.

3. 1993-1998: Assistant Professor department of Engineering Mathematics, Dalhousie University.

4. 1988-1993: Consultant applied mathematician, Beak Consultants, Toronto, Canada.

5. September 1989 - March 1990: part-time Postdoctoral fellow, OCIAM, Oxford University UK, with J.R. Ockendon.

6. September - October 1990, February - April 1991, and August 1991 -January 1992 and September 1992 - February 1993: Visiting Research Associate, OCIAM (with Dr. A.C. Fowler)

7. August 1993: Assistant Professor, Department of Applied Mathematics, Technical University Of Nova Scotia

8. July - August 1994, July 1995, July 1996: Visiting Research Associate, OCIAM (with Dr. A.C. Fowler)

4 Experience

4.1 Industrial

Provided project technical direction, 1988-1993, while at Beak Consultants Ltd., Toronto, Canada, for environmental engineering projects and project management relating to the development and modification of numerical models used to simulate the movement of contaminants in estuaries, lakes and rivers as well as underground contaminants.

4.2 Scientific

The following research subjects have been variously pursued during 1988 to the present. The current focus is mainly on the first two topics.

1. Neural control of the heart Unlike industrial controllers, neural controllers need noise to function and this dis- covery is proving important for experimental design, data analysis, and mathematical modelling of neural control. This work is conducted with a team of medical researchers and involves animal experimentation, data analysis, and mathematical modelling. Keywords: Aperiodic stochastic resonance, Neurocardiology, Pulsatile flow, Elastic arterial trees.

2. Industrial Control over IP The focus is on remote predictive control of manufacturing processes over noisy, shared networks. This work is conducted in collaboration with a controls group at University of New Brunswick, and involves hardware, physical and mathematical modelling. Keywords: Fuzzy logic, Model Predictive Control, Nonlinear optimization.

3. Exponential asymptotics The divergent tail of asymptotic expansions are usefully resummed to reveal subtle physics. This work is in collaboration with Dr. Andrew Fowler and involves the continuation of studies into developing exponentially corrected approximations. All problems studied stem from physical problems, e.g. ice sheet dynamics and climate prediction. Keywords: Asymptotic methods, exponential asymptotics, Borel summation, matched asymptotic expansions.

4. Ecg compression, and pattern recognition using fuzzy logic Quality controlled compression of biomedical signals is of general importance when data is discarded to decrease storage requirements. Keywords: Compression, Pattern recognition, Biomedical signal processing.

5. Signal Processing of Biological Signals The central tool is Takens theorem for the construction of a state space representation from a time series of measurements taken from a typically high order process. Methods to optimize this representation and further its development in prediction and noise removal are continuing. Keywords: State space, embedding, nonlinear prediction, noise filtering.

6. Mathematical Modelling of Passive Neurons These models are used to help distinguish parameters in neuron preparations. Asymptotic analysis and study of the inverse problem aids in the estimation of model parameters.

5 Peer-reviewed publications

1. G. Kember, A.C. Fowler, 'Random Sampling and the Grassberger Procaccia Algorithm', Physics Letters A, Vol. 161, pp. 429-432 (1992).

2. J. Evans, G. Kember, G. Major, 'Techniques for Obtaining Analytical Solutions to the Multicylinder Somatic Shunt Cable Model for Passive neurons' Biophysical Journal, Vol. 63, pp. 350-365 (1992).

3. A.C. Fowler, G.P. Kalamangalam, G. Kember, 'A Mathematical Analysis of the Grodins Model of Respiratory Control', IMA J. Appl. Math. Appl. Med. Biol., Vol. 10, pp. 249-280 (1993).

4. G. Kember, A.C. Fowler and J. Holubeshen, 'Forecasting River Flows using Nonlinear Dynamics', Stochastic Hydrology and Hydraulics, Vol. 7, pp. 205- 212 (1993).

5. A.C. Fowler, G. Kember, 'Delay Recognition in Chaotic Time Series', Physics Letters A, Vol. 175, pp. 402-408 (1993).

6. G. Kember, A.C. Fowler, 'A Correlation function for choosing Time Delays in Phase Portrait Reconstructions', Physics Letters A, 179 (1993) 72-80.

7. A.C. Fowler, G. Kember, P. Johnson, S. Walter, P. Fleming, M. Clements, 'A Method for Filtering Respiratory Oscillations', J. Theoret. Biol., Vol. 170, pp. 273-281 (1994).

8. J. Evans, G. Kember, 'Analytical solutions to the multi-cylinder somatic shunt cable model for passive neurones with differing dendritic electrical parameters', Biological Cybernetics: Communication and Control in Organisms and Automata, Vol. 71, pp. 547-557 (1994).

9. J. Evans, G. Kember, G. Major, 'Techniques for the Application of Analytical Solutions to the Multi-cylinder Somatic Shunt Cable Model for Passive Neurons' Mathematical Biosciences, Vol. 125, pp. 1-50 (1995).

10. G. Kember, J. Evans, 'Analytical solutions to the multi-cylinder somatic shunt cable model for passive neurones with spines', IMA Journal of Applied Mathematics in Medicine and Biology, Vol. 12, pp. 137-157 (1995).

11. A.C. Fowler, G. Kember, 'A Nonlinear Filtering Technique for Multi- Oscillator Systems', Computers Math. Applic., Vol. 29, No. 4, pp. 55-67 (1995).

12. A. C. Fowler, G. Kember, 'On the Lorenz-Krishnamurthy slow manifold', Journal of Atmospheric Science, Vol. 53, pp. 1433-1437 (1996).

13. G. Kember, A. C. Fowler, H. B. Evans, 'Local Nonlinear Filtering', Journal of Nonlinear Science, Vol. 7, pp. 411-425 (1997).

14. A. C. Fowler, G. Kember, 'Singular systems analysis as a moving-window spectral method', European Journal of Applied Mathematics, Vol. 9, pp. 57-79 (1998).

15. J. Evans, G. Kember, 'Analytical solutions to a tapering multi-cylinder somatic shunt cable model for passive neurones, Mathematical Biosciences, Vol. 149, pp. 137-165 (1998).

16. T. Blanchet, G. Kember, G. A. Fenton, 'KLT-based quality controlled compression of the electrocardiogram', IEEE Transactions on Biomedical Engineering, Vol. 45, No. 7, pp. 942-945 (1998).

17. S. Obrien, E. Gath, A. C. Fowler, G. Kember, 'Asymptotics with a small exponent in a model for ice-sheet surging', Proceedings of the Royal Irish Society, Vol. 1998a No. 1., pp. 67-80 (1998).

18. J. A. Armour, K. Collier, G. Kember, J. L. Ardell, 'Differential selectivity of cardiac neurons in separate intrathoracic autonomic ganglia', American Journal of Physiology, Vol 274, pp. 939-947 (1998).

19. A. C. Fowler, G. Kember, S. G. B. OBrien, 'Small exponent asymptotics', IMA J. Applied Mathematics, Vol. 64, pp. 23-38, (2000).

20. G. Kember, G. Fenton, K. Collier, J. A. Armour, 'Aperiodic stochastic resonance in a hysteretic population of cardiac neurons', Physical Review E, Vol. 61, pp. 1816-1824 (2000) (free pdf download from pre.aps.org archives using volume and page numbering).

21. G. Kember, A. C. Fowler, J. D. Evans, S. OBrien, 'Exponential Asymptotics with a small exponent', Quarterly of Applied Mathematics, Vol. 58, no. 3, pp. 561-576 (2000).

22. T. C. Blanchett, G. C. Kember, R. Dubay, 'PID gain scheduling using fuzzy logic', ISA Trans., Vol. 39, pp. 317-325 (2000).

23. G. W. Thompson, K. Collier, J. L. Ardell, G. Kember and J. A. Armour, 'Functional interdependence of neurons in a single canine intrinsic ganglionated plexus', Journal of Physiology, Journal of Physiology, Vol 528.3, pp. 561-571 (2000).

24. G. Kember, G. Fenton, J. A. Armour, N. Kalyaniwalla, 'A competition model for aperiodic stochastic resonance in cardiac sensory neurons', Physical Review E, Vol. 63, (March 29, 2001) (free pdf download from pre.aps.org, using volume number and article number 041911).

25. G. Kember, R. D. Foreman and J. A. Armour, 'Signal Noise in Neurocardiology', Comments on Theoretical Biology, Vol. 6, pp. 379-397 (2001).

26. G. Kember, J. A. Armour, G. Fenton, A. Malhotra, 'Noise from a decaying power spectrum and control of cardiac function', Phys. Rev. E 70, 021909 (2004).

27. J. A. Armour and G. C. Kember, Chapter 3, Basic and Clinical Neurocardiology, (Oxford University Press, New York, 2004).

28. G. Kember, J. Armour and M. Zamir,'Smart Baroreception along the Aortic Arch, with reference to Essential Hypertension', Physical Review E, Vol. 70, No. 5, 5 pages, (November 2004) (free pdf download from pre.aps.org, using volume number and article number 051914)

29. R. Dubay, G. Kember, and B. Pramujati, 'Well-conditioned model predictive con- trol', ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Vol. 43, No. 1, pp. 2332 (2004).

30. G. Kember, R. Dubay, and S. E. Mansour, 'Continuous Analysis of Move Suppressed and Lambda-shifted DMC', ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Vol. 44, No. 1, pp. 6980 (2005).

31. S. E. Mansour, G. Kember, R. Dubay and B. Robertson, 'Online Optimization of Fuzzy-PID Control of a Thermal Process', ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Vol 44., No. 2, pp. 305314, (2005).

32. G. Kember, R. Dubay and S. E. Mansour, 'On Simplified Predictive Control as a generalization of Least Squares Dynamic Matrix Control', ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Vol. 44, No. 3, pp. 345-352, (2005).

33. Dubay, R., Kember, G., Lakhsminarayan, C.V. and Pramujati, B., (October 2005), "Development of characteristic equations and robust stability analysis for MIMO move suppressed and shifted DMC", ISA Transactions: Journal of Science and Engineering of Measurement and Automation , Vol. 44, 4, pg. 465-479.

34. Abu-Ayyad, M., Dubay, R. and Kember, G.C., (October 2006), "MIMO extended predictive control implementation and robust stability analysis", ISA Transactions: Journal of Science and Engineering of Measurement and Automation , Vol. 45, 4, pg. 545-561.

35. Abu-Ayyad, M., Dubay, R. and Kember, G.C., (July 2006), "SISO extended predictive control Implementation and robust stability analysis", ISA Transactions: Journal of Science and Engineering of Measurement and Automation , Vol. 45, 3, pg. 373-391.

36. Dubay, R., Kember, G., Lakhsminarayan, C.V. and Pramujati, B., (January 2006), "Development of characteristic equations and robust stability analysis for SISO move suppressed and shifted DMC", ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Vol. 45, 1, pg. 21-34.

37. Abu-Ayyad, M., Dubay, R. and Kember, G.C., (January 2006), "SISO extended predictive control Formulation and the basic algorithm", ISA Transactions: Journal of Science and Engineering of Measurement and Automation , Vol. 45, 1, pg. 9-20.

38. Kember, G., Mansour, S.E. and Dubay, R. (October 2006), "Risk aversion predictive control", ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Vol. 45, 4, pg. 563-588

39. Waldman M, Thompson GW, Kember GC, Ardell JL and Armour JA 'Stochastic behavior of atrial and ventricular neurons', J Appl Physiol 101, 413-419 (2006)

40. G. C. Kember, J. A. Armour and M. Zamir, 'Mechanism of Smart Baroreception in the Aortic Arch', Phys. Rev. E 74, 031914 Sept (2006).

41. G. C. Kember, T. K. Kang, S. E. Mansour, 'A Continuous Analysis of Multi- Input, Multi-Output Predictive Control', ISA Transactions: Journal of Science and Engineering of Measurement and Automation, Volume 46, Issue 3, June 2007, Pages 419-428.

42. Shahin K., G. Kember and F. Taheri., 'An Asymptotic Solution For Evaluation of Stresses In Balanced And Unbalanced Adhesively Bonded Joints', J. of Mechanics of Advanced Materials and Structures, 15, 88103 (2008)

43. S. Y. Yoon, D. Hansen, G. C. Kember, 'A Matched Asymptotic Expansion Analysis Of Highly Unsteady Porous Media Flows, Trans. in Porous Media. June 2010.

44. S. Y. Yoon, D. Hansen, G. C. Kember, ''Multiple Scales Analysis Of Water Hammer Attenuation', Quarterly of Applied Mathematics. Accepted Oct 2010.

45. G. C. Kember, M. Zamir, J. A. Armour, 'Global and Local Control of Cardiac Function: The Concept of a Multilayered Controller, J. Theoret. Biol, submitted, 2010.

6 Funding

Funded by the Canadian Space Agency from 1994-1996, 150K. Project was mathematical modelling of directional solidification of gallium arsenide with Professor Noubar Yemenidjian of the department of mining and metallurgy at TUNS. Also funded through an NSERC operating grant (pure discovery grant) 10K per year since 1994. This grant has gradually increased to the present level of 15K per year (average grantee level is about 12K).

7 Patents

US provisional patent application No. 60/909,330 on KLT-Based Quality controlled Compression, with T. Blanchett and G. A. Fenton. (submitted July 1999). Full patent approval from US patent office obtained July 2000.

8 Principal collaborators

1. Professor J. A. Armour: Department of Pharmacology, University of Montreal, Montreal, Quebec, Canada.

2. Professor M. Zamir: Department of Applied Mathematics, University of Western Ontario, Canada.

3. Professor Rickey Dubay: Department of Mechanical Engineering, University of New Brunswick, Canada.

4. Dr. S. Mansour: Department of Engineering Mathematics, Dalhousie University, Canada.

5. Professor Gordon A. Fenton: Department of Engineering Mathematics, Dalhousie Univer- sity, Canada.

6. Professor Andrew C. Fowler: Oxford center for industrial and applied mathematics, Math- ematical Institute, Oxford University, United Kingdom.

7. Dr. Jonathan D. Evans: Department of Mathematical Sciences, University of Bath, United Kingdom.