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E-News December 2004 Edition

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43rd IEEE Conference on Decision and Control: PARADISE FOR CONTROL

Report by Mike Grimble

ACTC News

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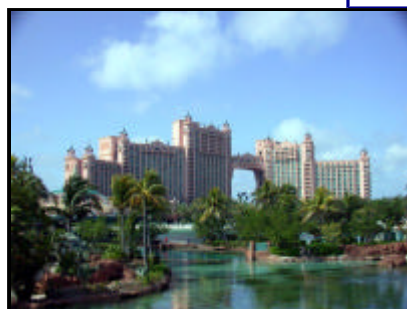
The 43rd IEEE Conference on Decision and Control was held at the Atlantis Hotel on Paradise Island, The Bahamas during December 2004.

The meeting was preceded by quite a large number of specialist workshops and it included some excellent plenary presentations and a number of valuable

panel meetings.

The first plenary presentation reminded me of my mortality since it was concerned with Control Theories in Critical Illness and Critical Care presented by Professor Timothy Buchman of Washington University. He claimed that critical care was a triumph of the last century. He noted that we now have devices such as mechanical ventilators, kidney dialysis machines and drugs that can sustain life through illnesses that were lethal only decades ago. Unfortunately, many patients fail to recover fully despite successful stabilisation and reversal of the process that triggered their illness. He then explored ways in which the recovery process and aftercare can be improved. He noted the ambiguities and conflicts that illuminate the opportunities for decision and control theories in the emerging field of systems biology and its application to critical clinical medicine. His presentation was very well received and it seems to open up a new area for Control Theorist and Practitioners.

There were a number of sessions concerned with Adaptive Control, Learning Systems and Iterative Learning Control Systems. Professor David Owens (Sheffield) chaired a session and gave two presentations on Repetitive Control Algorithms. He used the interesting idea of finite impulse response models for certain applications and discussed types of deadbeat control work for repetitive control. This seems to be an area where there is growing interest in the theory and it also has good applications potential.

The most prestigious presentation during the week was the Bode Lecture by Professor Tamer Basar of the University of Illinois. His talk was concerned with Games, Decisions and Control: Fifty Years Back, Fifty Years Forward. He provided a comprehensive review of previous fundamental work by researchers like Bode. However, most of his presentation was concerned with the subject of Game Theory. This may seem rather esoteric but it does lead to useful results for H_8 Control design of both linear and non-linear systems.

There were a number of panel discussions at the meeting and one was concerned with Industry-University interactions. The panel included Jeff Cook of Ford Motor Corporation and was organised by Dr Lalit K Mestha of Xerox Corporation. The Programme Director of the National Science Foundation talked about future research funding directions but the support for the industrial co-operation still seemed a little restricted.

The presentation by Jeff Cook of Ford at Dearborn showed their companies strong interest in and support for research with many links to US and non-Universities.

Another panel discussion was concerned with Graphical Programming Integration with Graphical Control Design and Simulation organised by Jeannie Falcon of National Instruments. The session included a comprehensive presentation of different control design, simulation and real-time facilities now available from National Instruments. The LabVIEW product is, of course, very well known but this has been considerably expanded and extended though related products which provide an integrated environment. This extends to producing an embedded system that can be utilised for prototyping and development.

Many of the new areas of control were reflected in the workshops and sessions including areas such as quantum systems, symbolic approaches to control, hybrid systems, nanotechnology, multivariable co-ordinated control, networks and many of the newer applications areas. One of the strongest applications seems to be automotive systems and they were several sessions covering this topic.

A session on Constraint Control included a number of papers on Anti-Windup Mechanisms. Dr Guido Herrmann (Leicester) described some new results on Anti-Windup Conditioning based upon the Weston-Postlethwaite Approach. This was followed by a talk by Deng (Okayama University) on Continuous-Time Anti-

Windup Generalized Predictive. This particular paper considered uncertain processes and systems and time delays.

Concluding remarks: This annual conference is mostly a showcase for new theoretical results and scientific advances. It reflects the changing nature of the subject and most of the topics now covered are very different to a decade ago. There are new areas where there are rapid advances and some that are developing slowly such as in adaptive systems. Other areas like Hybrid Control Systems are expanding rapidly with great interest from industry.

The conference was held in the Atlantis Hotel on Paradise Island in the Bahamas which may appear idyllic. Unfortunately, there were few places to be able to walk to and the conference hotel prices seemed to be suitable for the millionaire's yachts in the harbour. It was not a good venue to attract students.

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American Control Conference 2004, Boston
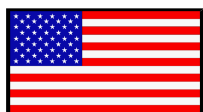
The 2004 American Control Conference was held in one of the United States leading Centres for technological developments, namely Boston in Massachucess. The conference attracts about a thousand people and a reasonable number of those are from industry. It also has excellent workshops and an exhibition. One of the highlights of the event is the award presentation to some of the leaders in control engineering. The Richard E. Bellman Control Heritage Award was given to Prof. Harold J. Kushner of Brown University. He is well known for his range of theoretical contributions to our subjects. The John R. Ragazzini (Education) Award went to Mark Spong of the University of Illinois and the Control Engeneering Practice ward went to William Powers of the Ford Motor Co. In recent years very new topics have emerged and there was for example significant interest and sessions on the subjects of hybridge systems control and controlling networks. The programme for the event can be obtained from Dr Andrew Clegg of the ACTC.

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Training Course: Ford, Dearborn, USA (10-12 Aug 2004)

A three day training course entitled "Introduction to Modelling, Simulation and Control for Automotive Applications" was given by the ACTC to Ford at their Dearborn offices in Detroit. The feedback we got from the delegates was very good, and many of them found the technical level of the material just right and the hands-on exercises very useful. The course was very well attended with about thirty engineers present, the maximum the classroom could hold. Indeed demand was so high that the same course is to be re-run in February, and it is also to be repeated for Ford engineers in the UK in October.

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Training Course: Ford, Dunton, UK (5-8 Oct 2004)

Following the success of the training course in Dearborn, the course was repeated for nine engineers from Ford at Dunton. The course was modified based on recommendations from Dearborn, and also extended to provide more time for hands-on sessions using Matlab and Simulink, with additional automotive examples being created. The course was held at Ford's new CEME training centre close to Dagenham, and on one evening the trainers and trainees had a break from the course at the excellent The Bell Inn (www.bell-inn.co.uk) in Horndon-On-The-Hill, Essex, which has a really excellent menu including dishes such as Parmesan ice-cream !

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Developments with On-Line Benchmarking Tool – PROBEwatch

Development has been on-going with our new on line version of our PROBE control loop benchmarking tool, called PROBEwatch.

The original PROBE software was launched to ACTC members back in Feb 2003. This stimulated much interest from ACTC members, particularly due to the flexibility offered by the more complex performance metrics for investigating loops that demand such close attention. High on the wish list of the members was the ability to automatically and continuously collect data from standard control systems and historians. This need stimulated development of PROBEwatch, to automatically gather data via OPC and generate loop metrics continuously. The performance metrics are to be made available to users by a number of means; regular or threshold activated email reports, a dynamic web-page, or by linking back into the process control databases.

The framework for PROBEwatch has now been developed, including the crucial OPC connectivity, and involves multi-threaded tasks to handle the data-gathering, metric calculation and metric reporting. The remaining tasks are concerned with adding usability and extensive testing, and this should take another 4 months of work (elapsed time) before a fully working prototype is available.

At this stage we are looking for development partners to assist in the testing of the tool, particularly with regard to the connection of PROBEwatch to a live OPC compliant plant control system. If your company would like to participate in the test program, we would be very pleased to hear from you. Further, any company wishing to hear more about the ongoing developments with PROBEwatch in more detail should contact Andy Clegg or Xiaohong Guan.

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ACTC Supported Project - "Improved Inverse Simulation"

A new collaborative research project is to undertaken between the Aerospace department of the University of Glasgow and the ICC. The project is entitled 'Improved Inverse Simulation through Nonlinear Predictive Methods' and will be an attempt to fuse the separately developed techniques of inverse simulation and nonlinear predictive control. It is hoped that in doing so, that solutions to the current deficiencies of each method (notably the inability of inverse simulation to handle constraints effectively and the need for representative initial state trajectories in NPC) will be removed in the resulting method. It is also the intention of the project to tackle one of the main theoretical issues outstanding in NPC - that of stability and the computation of feasible trajectories.

The case study upon which the new algorithms will be tested is a maritime helicopter approach scenario. A typical, industrially relevant example of this would be the final approach and landing of an EH101 helicopter onto the helideck of a Type-45 frigate. This scenario was chosen because of Glasgow's significant experience of helicopter simulation (UK centre of excellence in rotorcraft flight mechanics) and the ICC's extensive work on ship modelling and control. The ACTC is also going to directly involved in the project by supplying the ACTC's 6DOF ship model to the research team. In return, the researchers will provide regular progress updates to members via presentations at ACTC events.

The objectives of the project are quite ambitious and this is reflected in the size of the research team. The EPSRC grant is in excess of £400k which will provide for a post-doctoral researcher each at both Glasgow and Strathclyde and a PhD student at Strathclyde. The PhD student will investigate some of the practical implementation aspects of the algorithms developed with a view to real-time

implementation. The kick-off meeting is scheduled for early October 2004.

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Process Industry Experience in Automation Discussed at Manufacturing Excellence Conference

This year's Manufacturing Excellence, the process industry conference on the benefits of automation and asset management, was held from 15-17 June near Birmingham. The ACTC contributed one of the training workshops entitled "Introduction to Process Control".

The Manufacturing Excellence conference brings together experienced engineers and plant managers from the process industries, their contractors and suppliers, to learn, share best practice, and network with colleagues in the industry. Driving costs down and improving performance is essential year on year, and the conference has shown how this has been achieved, using modern automation and asset management techniques. Manufacturing Excellence 2004 presents the new techniques that can make tremendous efficiencies in how our plants operate.

The conference format featured the approach, successful over the past six years, of multi-stream parallel presentations, enabling each delegate to choose subjects to build a unique conference relevant to his interests. In addition attendees had hands-on access to an exhibition of products, equipment and software provided by approximately 30 suppliers, to see some of the techniques described, in action.

The main sponsors of the event were Emerson Process Management, Aker Kvaerner and IEE, and Institution of Electrical Engineers, with support this year from process industry manufacturers in the form of Huntsman International and BASF. The sponsors also appreciate the input received from quasi-government and professional bodies such as Action Energy and ISA, the UK section of the Instrumentation, Systems and Automation Society.

The conference programme is being developed at present, with papers already accepted from INEOS Chlor, on Generic Process Control: Brunner Mond, on Introducing Fieldbus: Huntsman Petrochemicals, on Using On-line Spectral Analysis: and BP Amoco Chemicals on What Diagnostics Users Would Like to See Developed Next! Further papers will discuss the users view of IEC61508, the integration of reliability-based maintenance, and the security risks of cyber attacks on control systems, plus many more. Full presentation details are available on www.manufacturingexcellence.net.

As usual the conference dinner and reception on Wednesday 16 June will be an evening to remember: both for the discussions and networking amongst presenters and delegates, and also for the after dinner speeches. This year's guest speaker is Sir Henry Cooper OBE KSG, the former European and British and Commonwealth heavyweight boxing champion.

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ACTC Event: Intelligent Control of Complex Systems, Strathclyde University, Glasgow, 27 May 2004

A meeting on the design of intelligent control systems was held at the University of Strathclyde on the 27th May 2004. This one-day meeting covered both new theoretical areas and potential application. The event was sponsored by both the ACTC and the EPSRC under a so-called 'cluster programme', and the event was opened by Mike Grimble also on behalf of Dr Amir Hussain from the University of Stirling, the cluster co-ordinator. The programme encourages building of consortia to investigate complexity in systems. Many of the presentations at the workshop considered the problems of complexity and how new tools might simplify the design process.

The highlight of the event was the keynote presentation by Prof. Goodwin (University of Newcastle, Australia) on convex and non-convex optimisation in complex systems. Prof. Goodwin has an international reputation that is second to none and is particularly noted for his strong theoretical research group but one which has numerous real applications. His presentation discussed the optimisation problem for complex processes and new potential algorithms that offer advantages in applications.

The second presentation by Dr. Becerra (University of Reading) considered problems in system identification and feedback linearisation using dynamic neural networks with a nice demonstration of robot motion control. Since complex systems are difficult to understand there are many that believe that intelligent methods are the way forward. A neural network can obtain models for processes where physical understanding is difficult to obtain and so, a natural tool to employ.

The presentation by Dr. Adgar (University of Sunderland) was concerned with the implementation of advanced control solutions in real industrial applications. His presentation includes an overview of a new software toolbox in Matlab that they have developed.

The presentation by Dr. Li (University of Glasgow) covered the use of evolutionary computing methods for the design of the industrial controllers. This type of technology handles complexity in systems but its roll within dynamic controllers still has to be fully determined.

Dr. Brown of the Control Systems Centre at UMIST considered the use of directional multi-objective optimisation in complex systems design. This is also very applicable for complex systems, since in most application there is a mixture of difference objectives to be achieved. Dr. Hatonen (University of Sheffield) gave a presentation covering the work of Prof. Owens in the area on the subject of iterative learning control and its applications. In many processes there is a repetitive element, like a robot that continuously repeats its actions. In such cases learning can be used to gradually improve the performance of the algorithms.

Dr. Vijayakumar (University of Edinburgh) also considered the use of learning to obtain internal models for use in control design. It is believed that learning systems are important in many areas of control systems and they will definitely have a use when complexity is present. He showed some very impressive video of robot control.

Prof. Lesecq (INP Grenoble, France) considered the challenges that arise in the control of connected and complex systems. The importance of pulling together results from computer science and control engineering was emphasised in this presentation.

The meeting concluded with a round table discussion on the opportunities provided under the EPSRC programme and the needs of industry in this area. Presentations were given by Dr. Giovanni (University of Strathclyde) on the program and by Prof. Najim (ENSIACET, France).

Following the meeting and using the comments from both the academic groups and the companies involved a cluster project EPSRC proposal was developed with ACTC support. The proposal includes ten universities and industrial support. The aim of the proposal is to undertake research in a number of areas that would enable the fundamental difficulties in handling complex systems to be understood and for tools to be developed that would simplify the process.

ACTC Members Can Download Presentation Just click here

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Study on Effect of Rudder Slew Rate on Roll Stabilisation MoD(N) - CS27/2004

This ACTC case study, carried out for the Ministry of Defence (N), investigates the relationships between rudder slew rate limits and roll stabilisation under different ship speed and heading conditions. Two ship speeds and two relative headings each (13 knots with 30 and 120 degrees, and 18 knots with 60 and 90 degrees) were the chosen conditions under which these relationships were determined. It would be expected that higher slew rate limits would improve roll reduction. However, the actual relationship-functions are required to determine an optimal rudder slew rate limit when considering other factors, such as cost, size, weight, etc..

As part of the study, some data processing was performed on the wave-roll transfer functions supplied by QinetiQ for the MoD. A rudder roll stabilisation controller was also designed as part of the work done. The evaluation of the different slew rate limits was done by means of a MATLAB/Simulink simulation model.

The work forms part of an ongoing series of roll stabilisation studies for the Marine Engineering Development Program (MEDP), which is being managed through the MAPS Development section of the Marine Auxiliary Section (MXS) IPT within the Warship Support Agency of the UK MoD.

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Training for Boeing, USA: "Advanced Control Analysis and Design"


The aim of this course (March 2004) was to introduce key concepts of advanced control analysis and design for multivariable systems.

The first day focussed on the fundamentals of state-space system modelling, simulation and cost function definition. The course then moved on to address control analysis and design techniques. State feedback and pole-placement design methods were discussed, followed by an introduction to optimal control methods such as LQG and its variations, including methodologies on how to specify the cost function and weightings to achieve given design requirements. An introduction to Kalman filtering accompanied by a critical analysis of its advantages and disadvantages was presented given the important role that this technique plays in the implementation of LQG controllers.

The second day covered the analysis of robustness and stability properties, and introduced the related methodologies of H-infinity and m-synthesis. The standard system description used in commercial design toolboxes like MATLAB was introduced. The course considered disturbance rejection and noise rejection properties and the inevitable trade offs with robustness and tracking requirements. Methods for improving robustness and reliability were introduced.

The third day introduced digital control and discussed three advanced multivariable control strategies that are deemed of great practical utility, namely, minimum-variance control, generalised predictive control, and techniques for decoupling multivariable control schemes. The training course included hands-on exercises using MATLAB and SIMULINK tools.

The course was given by Professor Haniph A. Latchman and Professor Oscar D. Crisalle, who co-ordinate the ACT-USA activities, and it was very well received by the staff at Boeing. Indeed there was so much interest that the course is to be repeated sometime over the Summer.
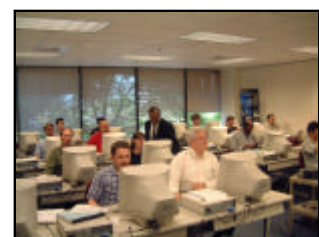
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ACTC Event: 3rd Automotive Special Interest Group meeting, National Instruments, Newbury, 4th Feb 2004

The 3rd Automotive meeting of the ACTC was held at the impressive new premises of National Instruments in Newbury during February. The meeting was very well attended by a number of the leading automotive companies represented in the contributions. The Chairman for the day David Shuttlewood of Ricardo introduced the meeting and the first presentation was by Keith Longmore of Lotus Cars. He talked about the problem of assessing the safety of automotive controls in the face of advances in technology. He was able to demonstrate that safe design is very much about a philosophy of thinking and working rather than building in individual features. The problem is of course much wider of that of just control systems but they do have an important role to play in safe automotive systems.

The second presentation was by Mathew Hancock and Bob Williams of Jaguar/Land Rover Research. They discussed the use of electronically controlled differentials on rear wheel drive cars. The control problems are challenging and the effects on handling and breaking are significant.

Jonathan Wheals of Ricardo discussed the AWD drive torque-vectoring demonstrator. Apparently, torque vectoring transfers torque by forcing small differences between the axles and this provides further degrees of control over the vehicle dynamics bringing in subjects like yaw rate control work into problems in flight control. Again the problems were extremely challenging and that Ricardo's progress impressive.

Dr. Tom Shenton and Mr. Georgios Triantos of the University of Liverpool gave a presentation on black box structure detection and powertrain models. The modelling of powertrains is important both to aid understanding of behaviour and also to enable model based control design to proceed. The main problems lie in the non-linearities and a practical way forward was presented.

After lunch Robert Morton of National Instrument (our host) described their tools for control design and for real-time control. Their company is making a large investment in the development of control design tools to compliment the very successful LabView product. In addition to developing Matrixx, which they now own, they are also producing new tools for LabView providing a very powerful facility with a very wide range of capabilities including the LabView FPGA data acquisition and analysis tool. The use of LabView in rapid proto typing and the use of the simulation interface tool kit was described by Dr. Paul Ingleby of BAE Systems. These particular tools and facilities were very relevant to the subject of the meeting and BAE Systems at Edinburgh are very experienced in using the LabView product in the Systems Technology Group.

To demonstrate that model-based techniques are not the only methods used Ian Blake of Jaguar Cars discussed fuzzy logic adaptive cruise control systems. This was work undertaken at Coventry University that demonstrated the potential that fuzzy logic controllers can provide. He was able to demonstrate a substantially improved performance using the method on simulations and vehicle assessment is now being considered.

Towards the end of the day a round table discussion was organised by the current Chairman of the Special Interest Group (Dr. Andrew Scarisbrick of Ford) and by David Shuttlewood. The initiatives the ACTC Special Interest Group should follow were discussed and many possible ideas debated. In fact, there was no shortage of ideas but it was necessary to try to home in on some practical and achievable targets. One of the conclusions was to hold the following meeting at the Gaydon Heritage Centre on Future Developments in the Control of Automotive Systems. It

was proposed that there would be a look to the future both from academics and engineers from industry. The possibility of holding a two-day workshop was also discussed and it was thought that a questionnaire might help so that the topics chosen would be of most interest. One of the suggestions was to have an introduction to different software tools but such a workshop could also concentrate on one type of problem such as powertrain controls. There was a strong flow of ideas from the attendees which all goes well for the future of the SIG.

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Applied Control Technology Consortium
50 George Street, Glasgow, G1 1QE, Scotland, UK   Last updated: 08/29/2006
                                                                      14:37:44
tel.: +44 (0)141 553 1111, fax: +44 (0)141 553
1232   © 1999 ISC Ltd.
email: actc@isc-ltd.com