The 2012 UKACC International Conference on Control (UKACC Control 2012)

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PLENARY SPEECHES

Plenary Speech I: Control for Performance Optimization
Professor Sebastian Engell, Technische Universität Dortmund, Germany

Abstract: In many applications, for example in chemical process control, good tracking of set-points or of trajectories is not a goal by itself but only of importance as long as it contributes to the safety and the performance of the process or system under control. The standard approach to tie performance optimization and control together is to compute optimal set-points or reference trajectories off-line and to track these trajectories using feedback control in order to compensate disturbances and plant-model mismatch. Often the computation of the optimal trajectories is based on rigorous, nonlinear models whereas the tracking controllers are based upon linear models, often obtained from measured data.Feedback control shifts variance from the controlled outputs to the manipulated inputs which may even be detrimental to plant performance. For tracking and disturbance rejection, model-predictive control has become a standard solution for multivariable problems. In model-predictive control, usually a cost function that contains the tracking error and the control effort is optimized online over a finite prediction horizon, taking into account state and input constraints. Due to the advances in numerical optimization algorithms, this approach can nowadays be extended to nonlinear, rigorous or data-based dynamic models. This provides the basis to go one step further and to integrate control with performance optimization by optimizing not the tracking of set-points but a more relevant performance criterion over the prediction horizon. This results in a direct optimizing control scheme. The feasibility and efficiency of this approach will be demonstrated for challenging chemical engineering application. In all model- and optimization-based approaches, model accuracy is a critical issue. In order to cope with potential model errors and uncertainties in external factors, a new robustification approach based on the idea of multistage stochastic optimization is presented and its efficacy is demonstrated for several case studies. Finally open problems will be will be discussed.

Speaker: Professor Sebastian Engell received a Dipl.-Ing degree in Electrical Engineering from Ruhr-Universität Bochum, Germany, in 1978 and the Dr.-Ing. Degree and the venia legendi in Automatic Control from Universität Duisburg in 1981 and 1987. 1984/1985 he spent a year as a PostDoc at McGill University, Montréal, P.Q and 1986-1990 he was the head of an R&D group at the Fraunhofer Institut IITB in Karlsruhe, Germany. 1990 he was appointed to his present position as a full professor of Process Dynamics and Operations in the Department of Chemical Engineering at TU Dortmund. He was Department Chairman 1996-1999 and Vice-Rector for Research of TU Dortmund 2002-2006. He served as Co-Editor of the IEEE Transactions on Control Systems Technology 1992-2000 and currently is Associate Editor of Journal of Process Control and of Mathematical and Computer Modelling of Dynamical Systems and a Member of the Editorial Board of the International Journal of Control. At TU Dortmund, he has graduated more than 50 PhD students. Dr. Engell is a Member of IEEE and a Fellow of the International Federation of Automatic Control (IFAC). He received best paper awards of Journal of Process Control for the period 2005-2008 and, with Thomas Tometzki, of the IEEE Congress on Evolutionary Computation in 2009. In 2011 he was awarded an ERC Advanced Investigator Grant for the Project MOBOCON – Model-based optimizing control – from a vision to industrial reality. His research interests are control and scheduling of chemical processing systems, hybrid systems and optimization-based process design.

Plenary Speech II: Control Systems Engineering: a Business-Driven Approach
Professor Peter Fleming, University of Sheffield, UK
Mr Stephen Hill, Rolls Royce, UK

Abstract: “What benefit will be realised?” “What will the cost impact be?” These are typical questions raised during the early stages of an industrial research programme involving control systems engineering. As a result, a distinctive and different kind of research approach arises due to this business focus. For example, before a topic such as model-based predictive control of gas turbine engines is explored, the question “In what way can the existing controller be improved?” must be addressed, eschewing any preference for the type of control that might realise the improvement. Though offering no gas turbine performance advantage, a new aero-engine controller concept is implemented because its design simplicity and robustness offer quicker, more affordable development (in service on the Boeing Dreamliner). Wireless sensors, seemingly ill-suited to safety-critical applications such as an aero-engine, prove to be of high value in test environments. The pursuit of sophisticated, novel health monitoring algorithms takes second place to developing solutions targeted at high-value, high-impact issues. Informed by business needs, control systems engineering has the potential to make an enormous impact. This talk, presented by Peter Fleming, will describe some of these

successes and will conclude with a question-and-answer section involving Stephen Hill and Peter Fleming.

Speaker: Peter Fleming is Professor of Industrial Systems and Control in the Department of Automatic Control and Systems Engineering and has been Director of the Rolls-Royce University Technology Centre for Control and Systems Engineering at the University of Sheffield, UK from 1993-2012. His control and systems engineering research interests include Control system design, system health monitoring, multi-criteria decision-making, optimisation and scheduling, and applications of e-Science. He has over 400 research publications, including six books, and his research interests have led to the development of close links with a variety of industries in sectors such as automotive, aerospace, energy, food processing, pharmaceuticals and manufacturing. He is a Fellow of the Royal Academy of Engineering, a Fellow of the International Federation of Automatic Control, a Fellow of the Institution of Engineering Technology, a Fellow of the Institute of Measurement and Control, and is Editor-in-Chief of International Journal of Systems Science. Further details may be found at http://www.shef.ac.uk/acse/staff/peter_fleming

Speaker: Stephen Hill has recently taken up the position of Technology Capability Manager for Aero Engine Controls, a joint venture between Rolls-Royce plc and Goodrich Corporation, who are the supplier of gas turbine engine controls to Rolls-Royce's Civil and Defence aerospace products. Previously, Stephen managed the control system technology development programme within Rolls-Royce, including guidance of the research strategy within the Control and Systems Engineering University Technology Centre. Stephen's research and technology career at Rolls-Royce stretches back over 30 years, covering a diversity of subjects, which include polymer composites, high performance electrical materials and more recently control and monitoring systems. He is a Chartered Scientist and Chartered Chemist.

Plenary Speech III: Aircraft Tonal Active Noise Control Techniques and Their Re-use
Mr Ian Stothers, Ultra Electronics Controls, UK

Abstract: Tonal active control has been available in turboprop aircraft for over 15 years with over 1200 systems in operation on over 10 aircraft types. The result has been turboprop aircraft with noise and vibration levels similar to jet aircraft. The design process used is

described, from equipment design through optimisation on the aircraft to diagnostics needed for operational maintenance. Designing the control and maintenance equipment has involved applying acoustics, electro-mechanics, signal processing, power control, optimisation and real-time control software. Some of the techniques used are outlined. Applying active control in aircraft has involved bring together many different ideas and areas of expertise. which have proven very useful in other areas , helping developments in a aircraft ice-protection, crack detection and landing gear control.

Speaker: Ian graduated from Southampton University with a degree in Engineering Noise and Vibration in 1985. His main interests have been control and active control in both aerospace and automotive engineering. Ian worked at Lotus Engineering for 6 years as a Technical specialist. Recent work has applied signal processing to aircraft ice protection, landing gear, active noise control, steering control on aircraft for Boeing, Airbus, Bombardier, Gulfstream and Embraer. He has worked for Ultra Electronics (Controls) for 15 years and as Technical/ Technology Director for the last 6 years.