On Discontinuous Observers: From Basic Properties to a Robust Fault Detection and Condition Monitoring Tool.

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Invited Seminar, Friday 16th of March, 2012, ROOM CG05, 14-15PM.

Abstract

Historically the sliding mode technique developed as a robust control method being characterised by a suite of feedback control laws and a decision rule. The decision rule, termed the switching function, has as its input some measure of the current system behaviour and produces as an output the particular feedback controller which should be used at that instant in time. The concept of sliding mode observers came later. These observers have unique properties, in that the ability to generate the so-called sliding motion on the error between the measured plant output and the output of the observer ensures that a sliding mode observer produces a set of state estimates that are precisely commensurate with the actual output of the plant. It is also the case that analysis of the average value of the applied observer injection signal, the so-called equivalent injection signal, contains useful information about the mismatch between the model used to define the observer and the actual plant. These unique properties, coupled with the fact that the discontinuous injection signals which were perceived as problematic for many control applications have no disadvantages for software-based observer frameworks, have generated a ground swell of interest in sliding mode observer methods in recent years. This lecture presents an overview of both linear and non-linear sliding mode observer paradigms. The use of the equivalent injection signal in problems relating to fault detection and condition monitoring is demonstrated. A number of applications specific results are also described.

About the Speaker

Professor Sarah Spurgeon graduated in Mathematics with first class honours from the University of York in 1985. Her DPhil was awarded for a study of the design and assessment of non-linear control systems for aircraft in 1988. She was appointed Lecturer in the Department of Mathematical Sciences, Loughborough University of Technology from September 1988, and moved to the Department of Engineering, University of Leicester in April 1991. Made a Senior Lecturer in October 1995, she was promoted to Reader from 1/10/2000 and was awarded a personal chair in April 2002. She has held a Visiting Professorship at the Ecole Centrale de Lille, a French Grande Ecole and was appointed Head of the Department of Engineering at Leicester University in August 2005. In July
2008 she was elected Fellow of the Royal Academy of Engineering for her "fundamental contributions to the development of nonlinear control and estimation methods, from theoretical developments through to trials and subsequent industrial support of technological exploitation". In August 2008, she moved with her research team to take up a Chair in Control Engineering and Head the Department of Electronics (now the School of Engineering and Digital Arts) at the University of Kent.

She currently serves on professional committees for the IMA and IEEE and has served on various IEE committees. Chair of UKACC (the UK Automatic Control Council), she joined the IFAC Executive Publications Committee by IFAC Council in 2008. She is an Editor of the IMA Journal of Mathematical Control and Information, a member of the Editorial Board of the International Journal of Systems Science, a member of the Editorial Board of the IET Proceedings and a Subject Editor for the International Journal of Robust and Nonlinear Control. She is an elected member of the EPSRC Engineering College and has received support from EPSRC and Leverhulme Trust as well as direct industrial support for her research work. She has provided consultancy and training services to a range of international companies including BAE Systems, TRW Connekt Ltd and Rolls Royce. She has supervised 15 successful PhD students, received approximately £4 million to support her research work from EPSRC, EU, the Government and Industry and published in excess of 250 refereed papers in internationally leading journals and the proceedings of international conferences. In 2000 she was awarded an IEEE Millennium medal and in 2010 was awarded the Honeywell International Medal for 'distinguished contribution as a control and measurement technologist to developing the theory of control'.

Her main areas of expertise are the development of practically realisable nonlinear control strategies which yield robust performance in the presence of uncertainty, and the design of robust condition monitoring schemes.