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Book Reviews

MODELLING CONTROL SYSTEMS USING IEC 61499: APPLYING FUNCTION BLOCKS TO DISTRIBUTED SYSTEMS, by Robert Lewis, The Institution of Electrical Engineers, London, 2001, xiv + 192 pp., ISBN 0-85296-706-9, IEE Control Engineering Series (Hardback, £36.00).

The standard specification to which the title refers allows not only modelling of digital control systems but also their efficient implementation and modification. The standard has been set up by the International Electrotechnology Commission, building on experience with earlier versions. The aim is to allow the rapid development and subsequent adaptation of complex control systems. The emphasis is on industrial automation, with no explicit mention of robotics, though there seems to be no reason why the methods should not be applicable there also.

The function blocks that are the basis of the approach are visualised as being implemented digitally, and may coexist in one computer or be distributed. One of the ways in which the scheme may facilitate system design and modification is by the reuse of existing blocks, perhaps with small alterations, and by the compiling of libraries of standard blocks. It is visualised that the design of control systems will become a matter of selecting appropriate standard blocks and deciding on their interconnections, in a manner analogous to the selection and interconnection of chips in the design of electronic devices.

As is acknowledged in the book, the approach has a great deal in common with modern ideas on object orientated programming. The principle of "inheritance", that features largely in discussions of such programming, is not carried over by that name to apply to function blocks, but similar results are achieved by "adapters" that can modify the action of a block. Reference is made to "polymorphic" behaviour to refer to the reusability of elements, possibly with modifications, in both contexts.

Function blocks are described as event-driven, which means that a particular block is activated when a specified set of conditions arises, essentially as in a discrete-event computer simulation scheme. Such an arrangement allows total flexibility. The scheme is designed to be compatible with an existing technology called "Fieldbus" which can connect sensors and actuators that are "smart" in the sense of embodying digital processors of their own.

The interior operation of a function block can be specified using any suitable computing language such as *Java* or *C*, provided the input and output channels are appropriately configured. Some special types of function block that are mentioned include communication function blocks, service interface function blocks, and management function blocks. The last-mentioned are able to download other blocks and initiate their action. Function blocks may also provide the functions of servers and clients in Internet terminology.

The pattern of interconnection of function blocks can be specified either by an Execution Control Chart that is essentially a state transition diagram, or by a set of production rules of the kind familiar in *AI*. Automatic means have been devised for translating between the two types of representation. An Appendix introduces the "textual syntax" needed for this, though without exhaustive treatment of it.

A further useful feature is that system specifications will be encoded in the *XML* language, described as the next generation markup language to replace *HTML*. This means that the specifications can be transmitted through the Internet and designers can work remotely.

In the book, the use of the technique is illustrated in two fairly simple industrial applications. Their simplicity should not obscure the potential value of this injection of the latest developments in computer software writing into control engineering, and the value of this little book in delineating it.

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NONLINEAR AND NONSTATIONARY SIGNAL PROCESSING, edited by W.J. Fitzgerald, R.L. Smith, A.T. Walden and P.C. Young, Cambridge University Press, Cambridge, 2000, xii + 471 pp., ISBN 0-521-80044-7 (Hardback, £60.00).

This is a collection of thirteen papers arising from a research "programme" held in the Isaac Newton Institute of Mathematical Sciences of the University of Cambridge from July to December, 1998. The Institute, according to a note in the book, exists to stimulate research in all branches of the mathematical sciences, and the research programmes it runs each year bring together leading mathematical scientists from all over the world to exchange ideas through seminars, teaching and informal interaction. Each of the chapters of the book was either presented as a talk at one of the workshops of the programme, or written as a research paper by one of the long-stay members.

In the Introduction it is explained that this programme was motivated by the observation that the whole field of signal processing and time series analysis has by now moved far beyond its roots in the theory of linear stationary processes, but many of the new techniques to handle nonlinear and nonstationary processes have developed in individual areas of statistics, engineering or more specialised fields such as environmental science or mathematical finance, with limited interaction between different groups.

As part of the programme activities, five open workshops were held, as well as numerous informal meetings. The topics of the five workshops were: (a) Bayesian statistics in signal processing, (b) environmental modelling, (c) the interaction between time series analysis and dynamical systems, (d) statistical methods in finance, and (e) data analysis with a particular emphasis on wavelet methods.

The proceedings are summarised in a useful four-page Introduction, in which it is noted that the particularly noteworthy achievements of the programme were new methodological developments and applications of wavelets, a wider appreciation of Bayesian methods, the interaction between nonlinear time series analysts and dynamical systems experts, and the development of new areas of application such as risk management in insurance and finance.

The idea of wavelets as an analytical tool dates back to a paper by Dennis Gabor as early as 1954. The final chapter of the present book discusses a development called "wavestrapping", also described as adaptive wavelet-based bootstrapping, used to examine the statistical properties of time series from either long or short memory processes. In an earlier paper a set of approaches denoted by the term “multitaper” is described. These overcome limitations of wavelet and spectrogram approaches by the use of a Loeve or dual-frequency transformation.

Some of the new methods reported under the heading of Bayesian inference have become feasible because of the availability of fast computers and sophisticated Monte Carlo simulation methods. Some intriguing display methods, for example one showing temperature distribution over a two-dimensional area as a three-dimensional perspective figure, appear in a paper on spatial statistics in environmental science.

The material reviewed in each chapter reflects the current “state of the art” and a fairly high level of mathematical sophistication is assumed. The density of equations is not particularly high, as mathematical texts go, and the discussion is lucidly presented. At the same time, a fair amount of background knowledge is assumed; this is obviously not a book for beginners. It is well produced, with numerous graphs and tables in the tidy style that is made possible by modern computer graphics, and on a few pages there are illustrations in colour. In some of these, colours are associated with a numerical range so as to allow effective plotting of values in an extra dimension.

The book will certainly be welcomed by those wishing to understand and apply the latest techniques in this area.

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