

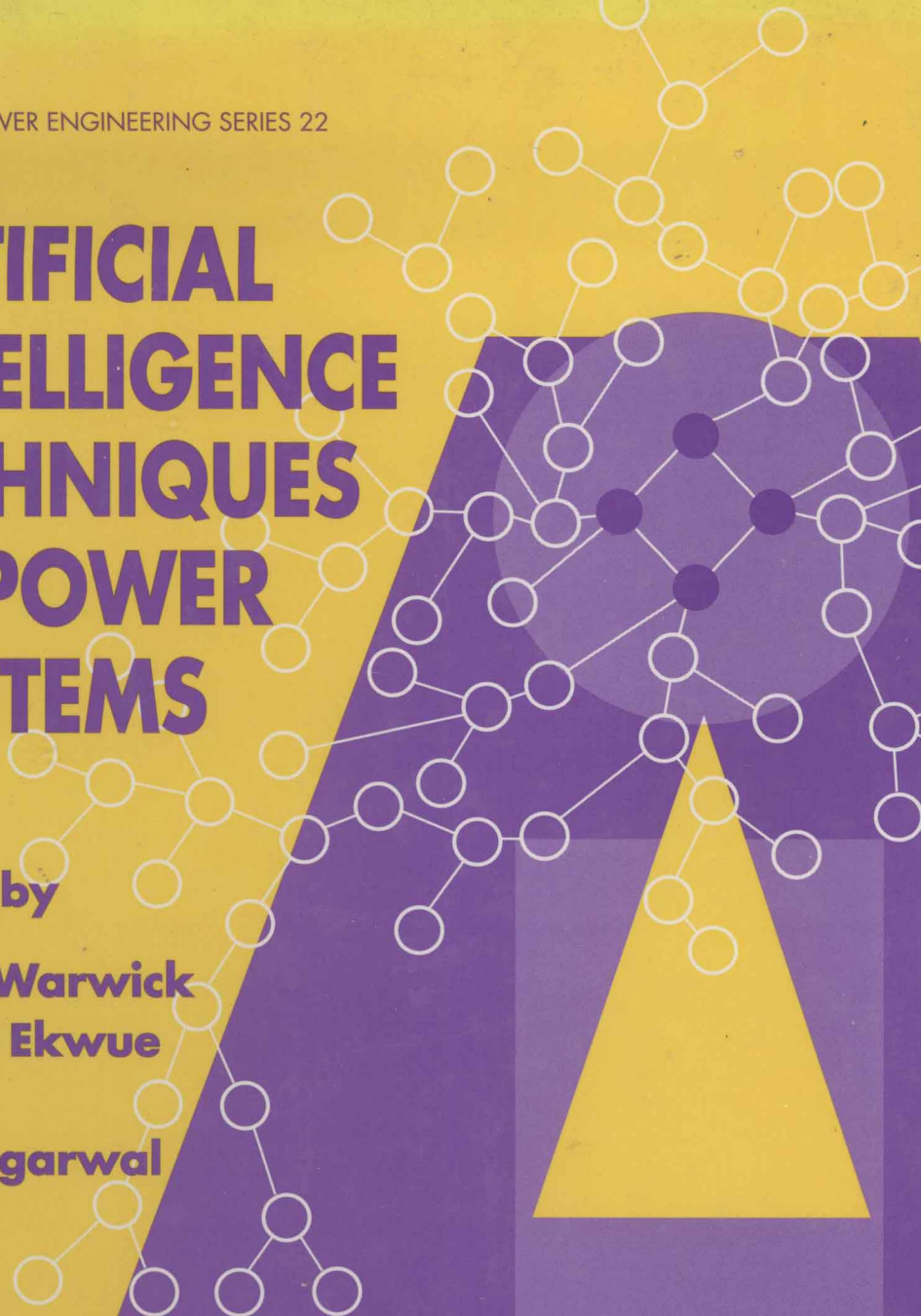


POWER ENGINEERING SERIES 22

# ARTIFICIAL INTELLIGENCE TECHNIQUES IN POWER SYSTEMS

Edited by

**Kevin Warwick  
Arthur Ekwue  
and  
Raj Aggarwal**



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The Institution of Electrical Engineers

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## Preface

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In the field of power systems one of the most exciting and potentially profitable recent developments is the increasing use of artificial intelligence techniques in monitoring, control and assessment. As a result of this, it was felt timely for a series of related articles to be put together to form a comprehensive guide which can serve as a reference text in the area. This book certainly serves as such a text, however it also provided the supporting material for a two-day workshop on the subject held at the University of Reading in January 1997.

The intention of the book is to give an introduction to, and an overview of, the field of artificial intelligence techniques in power systems, with a look at various application studies. The book should therefore be useful to a range of readers; including practising power systems engineers, researchers in the field and those studying the use of artificial intelligence.

In chapter 1 the subject of the book is introduced, in particular with methods such as knowledge-based systems, fuzzy logic, neural networks, genetic algorithms all being looked at for the first time. This chapter also contains a useful survey of developments in the area over the period 1990-1996. Chapter 2 takes a closer look at the use of knowledge-based systems through a relation checking algorithm developed at the University of Washington. This chapter describes work carried out for the Puget Sound Power and Light Company and concentrates on maintaining consistency in the rule base.

Chapter 3 introduces work on the use of object oriented software implementation for AI techniques. The use of a good Graphical User Interface (GUI) is stressed and it is explained how, by means of such a software approach, a range of complex applications can simply be 'bolted-on'. In Chapter 4 the use of fuzzy logic and fuzzy expert systems is investigated. Interestingly it is shown how hybrid systems can also be constructed in which fuzzy systems are mixed with either neural networks or genetic algorithms.

In Chapter 5 the particular application area of alarm analysis and fault diagnosis is described and it is shown how both expert systems and genetic algorithms can be successfully implemented. Chapter 6 meanwhile looks at voltage control, again showing how AI techniques can be made use of, particularly in trying to achieve fast and reliable real-time reactive power control. The use of AI for protection systems is then discussed in Chapter 7 and it is indicated that the integration of different AI branches can be extremely beneficial.

Chapter 8 contains an in-depth look at the use of neural networks for static security assessment. Various neural network topologies and methods are considered and it is shown how different end objectives can indicate that one approach is better than another. The need to pre-process data is however stressed. In Chapter 9 condition monitoring is the subject in question. Here issues of maximum financial benefit within constraints, such as technical and regulatory, are paramount. A particular point of interest looked at is the problem of integrating diverse reasoning systems.

Maintenance scheduling of transmission networks, by means of a genetic programming approach is considered in Chapter 10 and it is shown how relatively low cost schedules can be produced for a region within an overall network, also taking into account the need for network robustness. Meanwhile in Chapter 11 the use of a hybrid neural network/expert system approach is discussed in terms of a number of power systems application areas in particular alarm analysis, which was considered initially in Chapter 5. Again, the need to pre-process data is stressed.

The final two chapters both look directly at applications. Chapter 12 looks at the use of intelligent systems for demand forecasting, where, the need is to accurately predict the future load on the network, in the presence of daily and seasonal variations. Then Chapter 13, describes a practical application of the use of a neural network for autoreclose, in response to transmission line faults.

In its entirety the book gives an up-to-date, broad coverage of the possible uses of artificial intelligence in a power systems environment, as well as an indication of recent research progress. The book could easily be used as a comprehensive text giving a fair coverage of different aspects of the field or rather in terms of the individual chapters, each of which deals with a specific topic in depth. The intention is that the book is of use as much to those from a power systems background who wish to find out about how artificial intelligence techniques could be of use, as it is to those from an artificial intelligence background who would like to find out more about the specific power systems application area.

The Editors wish to thank each of the authors for their promptness in completing their chapter and, where relevant, for their help in modifying their work in putting together the finalised text. We would also like to thank Joanne Jones at the IEE for her assistance in putting on the Workshop at Reading University on which this book was originally based. Our gratitude also goes to Robin Mellors-Bourne at the IEE for his help in the production of the book. The major workload in putting the complete publication and overcoming incompatible word processing formats was however undertaken by Michelle Breadmore and Rachel McCrindle at Reading and without their input the book would not have come together — thank you.

Kevin Warwick, Reading University  
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January 1997

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