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Underwater Acoustic Systems

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Macmillan New Electronics
Introductions to Advanced Topics

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Series Editor's Foreword

The rapid development of electronics and its engineering applications ensure that new topics are always competing for a place in university and polytechnic courses. But it is often difficult for lecturers to find suitable books for recommendation to students, particularly when a topic is covered by a short lecture module, or as an 'option'.

Macmillan New Electronics offers introductions to advanced topics. The level is generally that of second and subsequent years of undergraduate courses in electronic and electrical engineering, computer science and physics. Some of the authors will paint with a broad brush; others will concentrate on a narrower topic, and cover it in greater detail. But in all cases the titles in the Series will provide a sound basis for further reading of the specialist literature, and an up-to-date appreciation of practical applications and likely trends.

The level, scope and approach of the Series should also appeal to practising engineers and scientists encountering an area of electronics for the first time, or needing a rapid and authoritative update.

Paul A. Lynn

Preface

This text is the result of a period of some fifteen years spent both researching and teaching, primarily at Master's degree level, aspects of underwater acoustics. Its content is aimed primarily at a professional engineering or advanced undergraduate and postgraduate student audience. It is the author's intention that the book should provide a brisk, comprehensive tutorial treatment adequately referenced so that the reader may readily delve further into its subject matter. Its first two chapters are concerned with the basics of the propagation of sound in the sea and with the preliminary assessment, via the Sonar Equations, of system performance. Often, both in these first chapters and, indeed, in the remainder of the text, the treatment of practical problems — for example, in modelling propagation behaviour — is handled empirically rather than theoretically. This is because the practising engineer, or the scientist seeking to utilise underwater acoustics in, for example, oceanographic investigations, frequently needs only a first-cut visualisation as to the scope or implication of a particular task, rather than a detailed mathematical dissection of the problem.

In contrast, in Chapter 3, some detailed consideration has been given to the need for and problems associated with waveform analysis, since this is often a most important way of gaining insight into the nature of both propagation and of system performance. Recent years have witnessed a dramatic increase in the power and availability of signal processing hardware together with a decrease in its cost. Additionally, there has been a considerable broadening of the scope of algorithmic techniques available for application to signal processing tasks, to the confusion of many who might benefit from the use of such methods.

Similarly, Chapter 5 delves into the complexities of Normal Mode modelling of sound propagation in the sea. In contrast to Ray Trace modelling (covered in Chapter 4) the Normal Mode approach is far from easy to appreciate. It is, however, of profound importance in describing propagation in shallow water, or at low frequencies, as well as in sound-channels or waveguides. Chapter 5 thus purports to present a map of the territory to assist the reader in venturing further into this intricate area of computer modelling. The author would wish to express his grateful thanks to Peter Willison, also of the School of Information Systems at the University of East Anglia, who played a major part in the writing of Chapter 5.

Chapter 6 deals, again often empirically, with the subjects of noise and reverberation in the sea. Some novel material is introduced here, in discussing the angular variability of ambient noise.

The subject of acoustic transduction is covered in Chapter 7, and is followed in Chapter 8 by a treatment of the formation of groups of transducers into arrays with preferred pattern propagation characteristics. It is unfortunately the case that the subject of acoustic transducer design is almost always but poorly treated — if treated at all — in texts on underwater acoustics. Indeed, the subject as a whole is inadequately covered in the scientific and technical literature and is almost invariably described by its proponents as being 90% black art and 10% science. This, of course, is to be regretted and is, in part at least, a consequence of a policy of need-to-know on the part of Naval Laboratories and Contractors and in part the result of a lack of commitment to fundamental research in this area during the past two or three decades. Regrettably also, the subject can be done but scant justice, in a single chapter, in a text such as this.

Chapter 9 reviews the utilisation of the various techniques discussed in the preceding chapters in the construction of a range of underwater acoustic equipments. In Chapter 10, the burgeoning new field of underwater acoustic communication, which is assuming considerable importance in scientific data gathering, communication with autonomous vehicles and sub-sea oil-field control and telemetry, is also treated in some detail.

Rodney Coates