Book reviews

Introduction to digital filtering in geophysics

xi + 168 pages

Geophysical observations are very like the result of a telephone conversation — one is trying to obtain some information in the presence of clicks and buzzes, cross-talk, disconnections and other disturbances. It is not very surprising, therefore, that geophysicists have taken over, and in some instances extended, the wealth of ideas, results and methods developed in information theory for the improvement of communications systems by filtering and deconvolution, and there is certainly a need for books which expound the principles of the methods of information theory and show how to apply them to problems in geophysics. To do that for observations recorded in digital form is the aim of this book, more particularly, the author says that he is concerned to explain these matters to those just beginning research in geophysics.

The book contains six chapters, the first on basic ideas including Fourier, Laplace and z-transforms, the second on design principles of digital filters and the third on applications to low, high and bandpass filters. The fourth chapter deals with correlation and optimum filters, and the sixth introduces multi-dimensional filters, particularly in relation to seismic arrays. The author, as befits a member of the Seismological Institute of Uppsala, chooses his examples almost entirely from seismology, but the techniques he sets out are applicable to much other geophysics, gravity and magnetic surveys, meteorology, ionospheric research and others.

Unfortunately, as an introduction to the subject for young research workers, the book is not wholly satisfactory. I find it insufficiently critical. Those to whom it is addressed need to be told more clearly and in more detail than they are, what pitfalls they may encounter when they use the various procedures. For example, when will a filtered seismic record show an onset shifted in time; when may deconvolution introduce spurious signals, and so on. These are mentioned, but it is not shown how the errors arise nor how common such phenomena are. Fig. 3.9, which shows a distortion of the onset, might have been discussed further in this connection. Linked with this issue is the need to discuss more fully the need to balance one defect against another (for example, ‘roll-off’ against Gibbs phenomenon) when designing filters. Again, in discussing interpretation of gravity and magnetic surveys, attention should be called to the inherent ambiguity of all interpretations.

Mention of the Gibbs phenomenon recalls another somewhat unsatisfactory feature of the book, the treatment of important theorems which are well known outside geophysics or even information theory. Instead of a full proof of a result and an indication of its background, we are too often given a mere reference to a seismological or information theory
text. I am thinking of the treatment of Gregory's finite difference formulae, contour integration, the Schwarz inequality among others, besides the Gibbs phenomenon. Again, in view of the importance of autocorrelation techniques, the one reference to their use is bizarre; the proof of the important theorem on the optimum signal to noise property of matched filters lacks important detail and more attention should have been given to the sampling theorem. What seems to me common to all these points is that the author has not clearly specified the background of those for whom he is writing so that to some extent the book falls between being an exposition of principles and being a critical catalogue of techniques for the geophysicist. In fact, for all the mathematical formulae that appear, the treatment is in general not rigorous but rather qualitative. That is not necessarily a bad thing, but as I have indicated, some of the fundamental theorems do, so I think, require a more rigorous treatment, more explanation and reference to their background, and more emphasis on their practical significance.

The book is about digital techniques so that it is natural that it is based to a large extent on sampling theory and z-transforms corresponding to the fact that digital measurements are made at finite intervals. The effect of the minimum step in measurement imposed by digital recording is also discussed. I feel that too much can be made of the difference between analogue and digital measurements in these respects. The minimum step in digital recording can often be made very small, much less than any noise level or than errors inherent in the measuring instrument, so that quantization errors are unimportant. As to sampling, although an analogue signal is indeed a continuous function of time, yet the fact that any instrument has a time constant means that its output is an integral over some finite time and so corresponds closely to digital sampling at that same interval of time.

It is unfortunate that the book is marred by poor proof reading and oversights in editing. A list one and a half pages long of errata has been inserted and in addition there are inconsistencies between the text and one or two of the figures, and some strange phrases in places.

However, I do not wish to end with adverse criticism. A great deal of valuable material has been collected and the book will be useful for those starting to use filtering techniques. In particular it is valuable to have a treatment of seismic arrays from this standpoint, a topic for which there is much original literature but no book.

A. H. Cook

Praxis der seismischen Feldmessung und Auswertung

R. Meissner and L. Stegema Gebrüder Borntraeger, Berlin

275 pages, DM 58.60

This book, whose title may be translated as 'The Practice of Seismic Field Measurements and Data Evaluation', is the first in a new series of student texts in applied geophysics. Subsequent volumes will consider theoretical aspects of seismic work and instruments and so these are not covered in any depth, but the relevant material is cross-referenced. The main emphasis is on reflection seismics but refraction work is also well described.

After an introduction to the geological background and general seismic work, sources and receivers are considered in detail with particular emphasis on the problem of ground-geophone coupling. The next section considers coherent noise and its suppression especially