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Book: Marine Bioacoustic Signal Processing

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LONG-TERM GOALS

As the number of researchers and students entering the field of marine bioacoustics has grown, the types of signal processing, measurement, and analysis have undergone a parallel increase in sophistication. Acoustic signal processing has long been the domain of electrical and mechanical engineers, physicists, and mathematicians. However, more and more biologists and psychologists are starting to use advanced signal processing techniques and analyses, especially with the influx of the many signal processing programs now available. What is lacking for many of these new users is an understanding of the theoretical underpinnings of different techniques. This has happened because the learning curve can be rather steep, especially for those in the biological and psychological sciences, and the theoretical constructs are often ignored or deemed to difficult to comprehend. This also applies to many students and beginning researchers with a physical science background, since various ideas and methodologies are scattered across different texts and manuscripts.

Dr. Whitlow Au, of the University of Hawaii, and I are writing a book on animal bioacoustics that brings together ideas, concepts and methods that are often found in diverse texts and manuscripts. [Dr. Au has a separate ONR grant and is not a co-PI on this one.] We are approaching basic principles from the perspective of processing and analyzing acoustic signals emitted by animals. The book is aimed at advanced undergraduates and beginning graduate students – people with some background in sound analysis who come from a background in either an animal communication or signal processing. Our goal is to make a practical guide by which people can understand and use the tools we have, rather than an theoretical exposition of the frontiers of our field. Such a book, written with animal bioacousticians in mind, is strongly needed in order for the field to grow in fruitful directions.

OBJECTIVES

The objective is to write a technical book on signal processing for bioacoustics, with particular emphasis on the issues faced by marine bioacousticians.

APPROACH

We (Dr. Au and I) are currently working on writing the book. The table of contents for the book is as follows:

1. Introduction
2. Introduction to digital signals

3. Filtering
4. Time/frequency representations
5. Equalization/normalization
6. Measurement and feature extraction
7. Localization
8. Tracking
9. Beamforming
10. Automatic call recognition
11. Call comparison
12. Call synthesis

Appendix: Recording techniques and equipment

Bibliography

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WORK COMPLETED

To date, the text and most of the graphics for Chapters 1-4 is completed, and Chapters 5-7 are in progress. We also have a publisher for the book, Springer-Verlag in New York.

RESULTS

This project does not really have technical results, as it comprises writing a book.

IMPACT/APPLICATIONS

It is hoped that this book, when published, will help educate a generation of marine bioacoustics researchers about methods for analysis of marine acoustic signals. The existence of a basic text such as this will allow graduate students and advanced undergraduates to learn the fundamentals of bioacoustic signal processing.

RELATED PROJECTS

Whitlow Au and Mardi Hastings are currently putting out an introductory book on bioacoustics. I believe this book is in the process of being published now.