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To Lori, who left us far too soon

Preface

This monograph presents a reasonably complete treatment of the model-based approach to the processing of data from underwater acoustic arrays. By complete we mean that the material herein is accessible to anyone at the level of a bachelor's degree in engineering, but may not be sufficiently familiar with the areas of statistical signal processing or acoustic array processing. With this goal in mind, it provides a reasonably rigorous treatment of standard time-domain statistical signal processing and acoustic array processing with an emphasis on its spatial processing aspects. A second reason for taking this approach is that since the processing philosophy presented here differs sufficiently from the standard approach, a review of the standard approach was warranted.

At its heart, model-based processing as discussed here is a form of Bayesian processing that relies heavily on physical models to provide the a priori information. This is done within the framework of the Kalman filter, since it itself is a Bayesian processor, and additionally provides a natural framework for including physical models, along with the ability of including prior information in a statistical form as in the usual Bayesian processor. Further, it is capable of easily handling the nonlinearities that accompany real-world models. By physical models we mean here such phenomena as array motion, array configuration, signal structures other than plane wave models, and oceanic propagation models. Because of this, the material presented here constitutes an approach to acoustic array processing that is capable of providing performance improvement over many of the presently used methods.

I would like to acknowledge Dr. James Candy, Chief Scientist for Engineering, the Lawrence Livermore National Laboratory for originally introducing me to the Kalman filter and emphasizing its applicability far beyond its original area of control theory. He made it clear that it provides a framework for performance enhancement to the field of signal processing and estimation theory in a very general way. I also gratefully acknowledge Dr. Allan Pierce, Professor Emeritus of Mechanical Engineering, Boston University, who encouraged me to write this book.

Portsmouth, RI, USA — Edmund J. Sullivan
December 2014

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