Battlefield Acoustics
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The new edition of this book attempts to provide the reader with all the background technical information and understanding needed in order to utilize acoustic sensing and the processing of its resulting data in order to increase the situational awareness of warfighters on the battlefield.

The author's stated overall goal of the book is to "provide the basics of battlefield acoustics and the issues involved" which will "be useful for practicing engineering students". In this main objective, the author has been largely successful, though treatment of the topic is at times covered at a rather introductory level and is relatively brief. Note that the book contains 12 short chapters, the first six of which are each no more than 10–20 pages long, and has a total of 250 text pages in length.

As is detailed below, the topic of battlefield acoustics is covered in this book from a more practical perspective and the resulting material reads as a somewhat niche and focused application and combination of a number of general technical areas. The book is organized as the integration of a collection of numerous rather disparate technical topics that together encompass the technical areas required for an examination of the use of atmospheric acoustic sensing for increasing battlefield situational awareness. Specifically, particular technical areas to which individual chapters are dedicated include acoustic theory, acoustic sensors and arrays, detection, classification, localization and estimation theory. The author does a good job at both (a) addressing each fundamental topic's particular relationship and unique issues as they relate to the battlefield-specific acoustic sensing application and (b) integrating and "stitching" together the individual topics into a coherent view of the big picture of battlefield acoustic sensing and data processing. However, as stated, some of these technical disciplines are not treated comprehensively or beyond an introductory level.

The first thing noticed by an examination of the book's table of contents is the slightly unusual choice and ordering of the early chapters, at least according to this reviewer. Rather than beginning the book as expected with a particular fundamental science topic (e.g., acoustics), the first four short chapter topics are ordered as follows: Chapter 1 contains a very short introduction to sound waves and different types of microphones, Chapter 2 focuses on probability concepts, Chapter 3 discusses detection theory, and Chapter 4 is dedicated to estimation theory and outlines a variety of common estimator approaches. In fact, the theory of acoustics is not introduced in the book until Chapter 5. The author does note in the book's preface, however, that readers familiar with these early topics in Chapters 2–4 may "skim or skip" them without negative consequences in comprehension of later chapters in the book.

Chapter 5 of the book, titled "Atmospheric Acoustics," is a surprisingly short chapter of approximately 12 pages, especially considering that this is a book centered on acoustics as its foundational technical element. However, it does at least briefly define and adequately introduce the reader to a number of fundamental acoustic phenomena topics, including sound waves, absorption, reflection, refraction and impedance. In addition, as with later topics, these general acoustic concepts are described with added emphasis given to the specific atmospheric acoustic medium and environment present on the battlefield.

Acoustic sensor arrays are discussed in Chapter 6, including the consideration of both linear arrays and circular arrays used for the detection, classification and/or localization of snipers, mortars, military vehicles, rocket-propelled grenade launchers and detonations, and even personnel. The related topics of acoustic beam forming, wave number transforms and beam steering are also briefly introduced in this chapter.

The most comprehensive and detailed sections of the book are contained within Chapters 7–12, where the focus shifts strongly towards the numerical processing of battlefield acoustic sensor data for target detection, localization and classification. Chapter 7 discusses data processing approaches for the bearing estimation of targets using acoustic arrays. In particular, the chapter discusses the calculation of the direction of arrival (DOA) of sound waves received from a sound emitter which is the critical first step towards achieving target localization, a major goal of battlefield acoustics situational awareness. Though relatively specialized, the printout of a detailed Matlab code script included in an example at the end of this chapter might be of use to readers interested in the practical programming of the minimum variance distortionless response (MVDR) beamformer algorithm.

The bearing or direction estimates for the target determined using the principles discussed in Chapter 7 are then assembled together in Chapter 8 where target localization and tracking (i.e., target localization at regular time intervals) are covered. Since the bearing estimates frequently contain measurement errors and noise, the majority of the Chapter 8 material following the tracking discussion covers a host of filters including Bayes, particle and several Kalman filter variants. In a similar vein to the Chapter 7 Matlab beamformer code,

Chapter 8 also contains a printout at its end of detailed Matlab scripts for programming basic, extended and unscented Kalman filters that might be illustrative for certain readers.

The book's ninth chapter, titled "Localization of Transient Events," illustrates the theory and methods of how to localize on acoustic events that are relatively brief and transient in nature. While the information in Chapter 9 is certainly applicable for larger-scale weapon's fire such as mortar launch and detonation events, the primary focus of this chapter is on sniper rifle fire and on the resulting sniper localization using both single and distributed sets of microphone arrays.

Chapters 10 and 11 together represent a pairing of chapters covering (a) popular classifier algorithms for the classification of targets from a more mathematical/numerical standpoint with (b) consideration of the specific target identity features used in these classifiers (from a physics-based, militarily-focused perspective), respectively. Combined together, the ultimate goal of this union is the accurate discrimination and classification of both vehicle and human personnel targets, reducing mis-identifications (e.g., incorrectly classifying animals as people), lowering false alarm rates, etc. The book's final and twelfth chapter contains a short, level discussion on the theory and properties of data fusion in the combination of multiple modality sensor data sets in order to provide for more accurate detection, localization and tracking processes.

The reviewer's examination of this book also brought out a few other, less content-based, impressions worthy of note. First of all, the language and style of writing of the author is very clear, straightforward and understandable, and is quite well-written from a pedagogical perspective. The figures, plentiful throughout the book, are well done, and are very clear and illustrative. In many cases they are printed in color which is helpful and attractive.

In addition, the book's references to existing literature are of satisfactory quality, condensed into single list of approximately one hundred located at the book's end and are liberally cited all through the book. It was noted that a large portion of these references consist of other book titles, rather than technical journal articles, which is expected given the more introductory level of many of the topics covered in this book.

Regarding the author's goal of providing a text suitable for practicing engineering students, this reviewer believes that this book, at least in its first edition form, might unfortunately fall short. To begin with, there are too few examples within the book illustrating the application of the principles and theories covered; the reviewer counted approximately nine in the entire book, with nearly half the chapters having none. Secondly, there were none of the homework-type problems usually found at the end of each chapter in most university textbooks. The inclusion of additional worked example problems and homework questions would definitely strengthen any future edition of this book in this respect.

The strength of this text is in its relatively practical and straightforward approach to describing the application of numerous underlying technical disciplines towards the goal of increasing battlefield situational awareness utilizing improved acoustic data sensing and processing. In addition, though the author has attempted to briefly introduce underlying concepts relative to basic acoustic measurements such as atmospheric acoustics and acoustic sensors and sensor arrays, the book's biggest strength lies in the second half chapters containing the descriptions of the various numerical data processing approaches required for detection, localization, classification and tracking in the field of battlespace acoustics. The book will likely be of most use to practicing engineers interested in an introduction and broad overview to the battlespace acoustic sensing field. For readers coming to this book from that perspective, it is certainly recommended.

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