Matched Doppler Processing

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Contents

List of Figures

List of Tables

Abstract

This thesis describes a method for estimating the ranges and speed of a nearfield narrowband sound source as it moves past a receiver. This is applied to analysis of source motion in the underwater acoustic environment.

The technique correlates or "matches" the receiver output with a large set of replicas. A replica is generated for each combination of possible candidate source ranges and speeds. These replicas are generated according to a simple propagation model which takes into account the doppler effects inherent in the motion of the theoretical source.

Particular emphasis is placed upon the treatment of signal phase. This is carefully modelled in the replica by considering the differential time–lag and DFT cell distortion induced by the doppler effect. The matching functions exploit this phase information by processing it coherently.

The matched processing algorithm is tested with both simulated data and real data from a sonobuoy. Performance bounds of the estimators are derived and discussed in context with the simulation results. It is shown that the phase–coherent matching functions satisfy these bounds. The robustness of the technique to variance in the source trajectory is investigated through further simulation.

The technique is extended to perform tracking of source range, azimuth, speed and heading with the use of multiple receivers. A matching function which processes phase coherently across space as well as time is presented. This is compared to a spatially–incoherent formulation via extensive simulation.

Publications

- S.J. Searle & D.A. Gray, "Environmental Source Tracking and the Doppler Shift", presented at ISSPA-96, August 26–28, 1996.
- S.J. Searle & D.A. Gray, "Matched Doppler Processing for Estimating Moving Source Parameters", submitted to the Journal of the Acoustical Society of America, April 1997.

Statement of Originality

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

SIGNED:

DATE: 13/2/98

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