MIMO Sonar and SIMO Sonar: A Comparison

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Abstract--- In the single input multiple output (SIMO) sonar system, the transmitting antennas send coherent waveforms which form a highly focused beam. In the multiple input multiple output (MIMO) sonar system, the transmitter sends independent broad waveforms. These waveforms can be extracted at the receiver by a matched filter bank. The extracted signals can be used to obtain more diversity or to improve the spatial resolution for clutter. MIMO sonar can achieve superior performance through waveform diversity over SIMO sonar.

This paper work focuses on the comparison of the performance of MIMO sonar against SIMO sonar for the target detection and localization. The capon beam forming problem for SIMO and MIMO sonar systems is formulated and the two systems are being compared for the case where the transmitter and receiver arrays are co-located. The capon beam formed output in MIMO offers advantages in terms of resolution and output signal to noise ratio compared to that of SIMO. Simulation results confirm the theoretical observations and demonstrate the effectiveness of the proposed MIMO sonar technique.

Index Terms--- SIMO, MIMO, Beam Forming

I. INTRODUCTION

Recently, the concept of multiple input multiple output sonar has drawn considerable attention due to the additional degrees of freedom and improvement in performance it offers over SIMO sonar. In SIMO sonar, the transmitting antennas are limited to transmit scaled versions of the same waveform. The MIMO sonar employs multiple antennas to emit several independent waveforms and multiple antennas to receive the echoes reflected by the target. By transmitting independent waveforms via different antennas, the echoes due to the targets at different locations are linearly independent of each other, which allow the direct application of many data-dependent beam forming techniques to achieve high resolution and excellent noise rejection capability[4]. Therefore, adaptive receive filter such as Capon filter can be directly employed in MIMO sonar applications.

The SIMO and MIMO systems are studied in this paper work and for the comparison of these two systems the Capon beam forming method is formulated and simulated. The beam former design problem has been investigated extensively for several decades due to its wide applications in many fields including array processing, spatial filtering, interference suppression, smart antenna systems etc. Beam forming techniques are mainly classified into two types which are conventional and adaptive. The most well- known adaptive beam former namely the minimum variance distortion less response (MVDR) beam former which is also a capon beam former is proposed in this paper.

The problem selected for the paper work is the comparison of SIMO sonar against MIMO sonar for target detection. The comparison was done using Capon beam forming technique. The comparison of beam formed outputs in made for the above specified systems. The simulations are done in Matlab. Benefits of capon beam forming in MIMO sonar compared to that of SIMO sonar are 1) Resolution enhancement and 2) Improved output signal to noise ratio.

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