

https://dspace.org/

The design and implementation of an acoustic phased array transmitter for the demonstration of MIMO techniques

Middleton, Sarah

2011-11-07
http://hdl.handle.net/10539/10713

Downloaded from a DSpace repository. https://dspace.org/

Abstract

MIMO radar algorithms are the latest generation of techniques that can be applied to array radars. They offer the potential to improve the radar resolution, increase the number of targets that can be identified and give added flexibility in beampattern design. However, little experimental data demonstrating MIMO radar is available because radar arrays are already expensive systems and MIMO extends the complexity and cost further. An acoustic array, which works on the same principles as a radio frequency radar array, can be built at a fraction of the cost of a real radar system. The novel contribution of this project was the demonstration of MIMO radar techniques on an acoustic array, which was designed and built for this purpose.

To achieve the project objectives, the theory of traditional phased array radar techniques and MIMO techniques was researched. The phased array and MIMO techniques were also simulated under narrowband and wideband conditions, and the strengths and weaknesses of each were highlighted. This was followed by the design and implementation of a low cost audible acoustic transmitter array to be used with an existing receiver array to demonstrate the investigated array radar techniques. Finally, the techniques were tested on the hardware platform.

The simulation and hardware test results were used to evaluate and compare the performance of phased array and MIMO radar techniques. The beampattern design flexibility that is offered by MIMO radar was demonstrated with the transmission and measurement of omnidirectional, single-lobed and multi-lobed MIMO beampatterns. Also, parameter estimation experiments were performed where phased array and MIMO radar signals were transmitted. Phased array techniques were shown to be simple, effective and robust. The MIMO Capon, APES and GLRT parameter estimation techniques were shown to be sensitive to the type of signals transmitted, and in most cases, the added complexity of these techniques did not lead to improved target parameter estimation results. However, the MIMO technique of transmitter beamforming on reception gave high resolution target range and angle estimates, living up to the expectations placed on MIMO radar.