

STUDIES ON CIRCULAR ARRAY BEAMFORMING
FOR SONAR

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CERTIFICATE

This is to certify that the thesis entitled 'Studies on Circular Array Beamforming for Sonar' being submitted by RAJENDAR BAHL for the award of the degree of Doctor of Philosophy to the Indian Institute of Technology, Delhi, is a record of bonafide research work done by him under my supervision. The results contained therein have not been submitted to any other University or Institute for the award of any degree or diploma.



(Prof.P.V.Indiresan)

To my parents

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ABSTRACT

This thesis is concerned with studies on circular array beamforming for SONAR.

The circular array is finding increasing use in present-day sonar systems. Its usefulness can be ascribed to its symmetry which affords efficient formation of multiple beams for scanning the sonar environment. However, the circular array intrinsically suffers from a poor sidelobe ratio as compared to a linear array. The limitation of bandwidth of the array is also a matter of concern in sonar applications. We have, therefore, in this thesis adopted an integrated approach to study specific problems in circular array beamforming. The emphasis is on obtaining an insight into these problems and to propose ways of obtaining the maximum advantage from particular beamformer configurations.

The problem of beam pattern degradation due to phase error has been studied in detail. This knowledge has then been applied to the case of digital phase quantization and guidelines evolved for minimising the pattern degradations. The study of amplitude tapers has been made to analyse their pattern modification ability. The effect of some of these tapers on the bandwidth and beamwidth has been studied and compared with the special case of arc-arrays.

The phase-shift beamforming technique as applied to multiple-beam-steering has been studied. The combined effects of spatial sampling and demodulation have been analysed to reduce the frequency - dependent beam-squint. The spatial domain processing approach has also been investigated and a fresh insight into sidelobe reduction has been obtained.

A new beamforming structure - the Delta Modulation beamformer has been proposed and studied in detail. Compact hardware structures have also been put forth. The Delta Modulation beamformer has been built in hardware and its performance studied with the help of simulated signals and noise.

The various analytical results obtained have been largely verified and supported by computer simulation studies.

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