Public Abstract
Yunhong Li
Ph.D.
Electrical and Computer Engineering
Broadband Beamforming and Direction Finding Using Concentric Ring Array
Advisor: Dr. Dominic K. C. Ho

---
advisor's signature

Graduation Term: Summer 2005

Sensor arrays have been used widely in applications including radar, sonar, seismology, biomedicine, communications, geophysical exploration and imaging. A very popular type of sensor array is circular array. It has several advantages such as the fact that it can perform 360° scan around its center very conveniently and during the scan the array pattern can be kept almost invariant. In our research, we consider beamformer design and direction finding for a broadband source using concentric ring array(CRA) that contains many concentric rings of different radii. Such structure yields several advantages including the flexibility in array pattern synthesis and adaptive array design. Previous works on controlling the array pattern of CRA only address narrowband scenario. The research on CRA conducted here is aimed for broadband beamforming applications.

This dissertation considers the problem of applying the CRA to broadband signal acquisition that includes direction of arrival(DOA) estimation and beamforming. In beamforming, both deterministic and adaptive design have been derived. The proposed beamformer designs, for both deterministic and adaptive, use the novel idea of decomposing the weights of the array into two sets: inter-ring weights and intra-ring weights, and they are chosen separately using different criteria. For deterministic design, three array pattern synthesis techniques are proposed to control the sidelobe and/or mainlobe width of the array pattern. Two of them are based on Fourier-Bessel expansion and one uses minimum mean-square error design. We then proposed a flexible adaptive broadband beamformer design through the partially adaptive and subarray concepts that yields good interference cancellation performance even in highly hostile signal environment. Finally, we proposed an efficient broadband DOA estimation technique for the CRA. The proposed design techniques are corroborated by experiments from simulated as well as measured data.