

# DISTINGUISHED LECTURER SERIES



## P. P. Vaidyanathan

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Engineering  
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### Reception

Tuesday, Sept. 14  
4:30 pm  
1146 A.V. Williams Bldg.

### Lecture

Tuesday, Sept. 14  
5:00 pm  
1146 A.V. Williams Bldg.

### Roundtable discussion

Wednesday, Sept. 15  
10:30 am  
1146 A.V. Williams Bldg.

### Host

Min Wu

Tuesday, Sept. 14, 2010 5:00 p.m.

## Sparse Sensing with Coprime Sampling Lattices

### Abstract

Imagine a pair of uniform samplers operating simultaneously on a signal. With the sampling rates arbitrarily small, is it possible to extract any useful information about the signal at all? Yes! Under some conditions of stationarity it is possible to recover second order statistical information, which is sufficient for many applications. For example, from samples of  $x(t)$  taken at the sparse rates  $f_s=M$  and  $f_s=N$  (where  $M$  and  $N$  are arbitrarily large but coprime), it is possible to estimate the autocorrelations at the dense sampling rate  $f_s$ : The enabling principle in these applications comes from the theory of sparse coprime sampling.

This talk focuses on this theory. Although the technique has surfaced in some applications in the distant past, a systematic development of the theory has evaded attention. We discuss both one and multidimensional cases, and present applications both for temporal and spatial signals. In the multidimensional case, coprime sampling involves the construction of coprime lattices, a very interesting problem mathematically. One outcome is that under some conditions it is possible to combine two DFT filter banks with  $M$  and  $N$  bands and make them operate like an  $MN$ -band filter bank. Similarly it is possible to combine two sensor arrays with  $M$  and  $N$  sensors, such that there are  $O(MN)$  degrees of freedom, say, for beamforming and direction-of-arrival estimation (e.g.,  $O(MN)$  sources can be identified with  $M+N$  sensors).

Similarly it is possible to compute a spectrum with resolution proportional to  $1/MN$  by combining two systems which would individually produce only resolutions of  $1/N$  and  $1/M$ : A non standard application of this theory is in channel identification: somewhat surprisingly, a complex channel (not just second order information) can be identified by sending a pulse stream at an arbitrarily low rate and sampling the channel output at another arbitrarily low rate, coprimally related to the transmission rate. This talk will give an overview of sparse coprime sampling theory, and elaborate on some of the above applications.

### Biography

P.P. Vaidyanathan has been with the California Institute of Technology since 1983. His main research interests are in digital signal processing, multirate systems, wavelet transforms, digital communications, genomic signal processing, radar signal processing, and sparse array signal processing. He has authored more than 400 papers in journals and conferences, and is the author of the three books Multirate systems and filter banks (Prentice Hall, 1993), Linear Prediction Theory (Morgan and Claypool, 2008), and (with Phoong and Lin) Signal Processing and Optimization for Transceiver Systems (Cambridge University Press, 2010).

He was recipient of the award for excellence in teaching at the California Institute of Technology multiple times. His papers have received awards from IEEE and from the IETE (Institute of Electronics and Telecommunications Engineers, India). Dr. Vaidyanathan is a Fellow of the IEEE, recipient of the F. E. Terman Award of the American Society for Engineering Education, past distinguished lecturer for the IEEE Signal Processing Society, recipient of the IEEE CAS Society Golden Jubilee Medal, and recipient of the IEEE Signal Processing Society Technical Achievement Award.

Questions?  
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