



**Princeton University**

**Department of Electrical Engineering**

# **Information Sciences and Systems (ISS) Seminar**

- Speaker:** Visa Koivunen  
Helsinki University of Technology, Finland
- Date:** Tuesday, May 15, 2007
- Time** 4:30 pm ~ Room B205 ~ EQuad
- Title:** Riemannian Geometry Based Methods for Optimization under Unitary Matrix Constraints

**Abstract:**

In many engineering applications we deal with constrained optimization problems w.r.t. complex valued matrices. We propose Riemannian geometry approach for optimization of a real valued cost function  $J$  of a complex valued matrix  $W$ , under the constraint that  $W$  is an  $n$ -by- $n$  unitary matrix. Such optimization has applications in beamforming, space-time coding, subspace estimation, signal separation as well as MIMO systems.

We derive steepest descent and conjugate gradient algorithms on the Lie group of unitary matrices  $U(n)$ . The algorithms satisfy the constraint exactly unlike methods based on Lagrange multipliers. The proposed algorithms move towards the optimum along the geodesics, but other alternatives are also considered. We also address the computational complexity considering both the geodesic and the non-geodesic steepest descent algorithms. Armijo step size adaptation rule is used. Simulation examples in MIMO communication systems are provided.