Fall 2006

EE 503
Homework #2
Due: Oct. 18, 2006

In class, we have covered orthogonal matrices, projection matrices and systems of under-over determined linear equation systems. With this assignment, we would like to unify many concepts into a single framework. To do that, properties of **Singular Value Decomposition** (SVD) is asked to be compiled and presented as a *group report of at most three students.*

The report should at least: explain the geometrical meaning of SVD operation, explain the connection between Polar Decomposition, QR decomposition and Cholesky Decomposition and SVD, explain the connection between pseudo-inverse for under-over determined systems and SVD and finally low rank approximation property.

You are free to use any reference you wish. Also below is a list of topics that is easier with SVD, you may want to discuss these in your report. You can add many more items to the list.

Linear Algebra:

1. Finding the range space of a matrix.
2. Finding the null space of a matrix.
3. Finding orthogonal projectors to null/ range space.
4. Expressing orthogonal projectors to range space, $\mathbf{P_A}$, in terms of matrices appearing in SVD factorization.
5. Expressing complementary projector $\mathbf{P^C_A}$ in terms of matrices appearing in SVD factorization.
6. Pseudoinverse

Approximation (Lossy Compression):

1. The relation between Frobenius norm and singular values.
2. Low rank approximation of a matrix (a.k.a. principal component analysis)

Decompositions:

1. Polar
2. QR decomposition
3. Cholesky

References:

[Therrien]: Discrete Random Signals and Statistical Signal Processing
[Hayes] : M. H. Hayes, Statistical Signal Processing and Modeling,
[Scharf] : Louis L. Scharf, Statistical Signal Processing,
[Strang] : Strang, Gilbert, Introduction to Linear Algebra.
http://ocw.mit.edu/OcwWeb/Mathematics/18-06Spring-2005/Readings/index.htm