

Digital Video Processing (EE392J)  
Department of Electrical Engineering  
Stanford University

*Problem Set No. 5*

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Issued: Wednesday, February 21, 2007

Due: Wednesday, February 28, 2007

Brief Oral Project Descriptions: Wednesday, February 28, 2007 (see next page)

Office hours: Wed (2/21) and Mon (2/26) after class, and Friday (2/23) 2:00-3:00.

Please feel free to stop by office hours to talk about possible projects.

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Problem I. Constraint-based Signal Recovery: POCS when each constraint is a subspace

This problem considers constraint-based signal recovery in the special case where each constraint corresponds to a subspace. Assume that the desired solution satisfies a linear equation of the form  $a_1x_1 + a_2x_2 + \dots + a_Nx_N = 0$ . This equation can be equivalently expressed as  $\mathbf{a}^T \mathbf{x} = 0$  where  $\mathbf{a} = [a_1, a_2, \dots, a_N]^T$  and  $\mathbf{x} = [x_1, x_2, \dots, x_N]^T \in \mathbb{R}^N$ . Therefore, the solution must lie in the  $(N - 1)$ -dimensional subspace defined by  $\mathbf{a}^T \mathbf{x} = 0$ .

(a) Determine an expression that describes how to compute the orthogonal projection of an arbitrary point  $\mathbf{x}$  onto the subspace. The orthogonal projection of an arbitrary point  $\mathbf{x}$  onto a subspace is the point in the subspace that is closest (in Euclidean distance) to the point  $\mathbf{x}$ . (Hint: Think projection theorem or least squares.)

(b) Assume that the desired solution satisfies two linear equations of the type shown above. Also assume that the corresponding subspaces intersect. Is there a unique solution? If not, what is the form of the solution, e.g., what is its dimension?

(c) Assume you perform alternating orthogonal projections to determine an element in the solution set. How does the convergence rate depend on the “angle” between the subspaces? (Hint: Consider the analogous case of two 1-D subspaces in a 2-D space, i.e., when you have two linear equations in two unknowns. What happens when the subspaces are orthogonal? What happens when the angle between them is very small?)

(See Back)

## Problem 2. Brief Oral Project Description

The goal of this brief presentation is twofold: (1) to describe to your classmates what you are working on for your final project, and (2) to provide an opportunity for additional feedback which may help improve your final project.

- **Presentation length:** Your presentation should only be about 7-8 minutes in length, followed by a few minutes of discussion and Q&A. Therefore, you should have between 4 and 8 slides total, including title slide.
- **Presentation format:** Use whatever format is most convenient for you. If you have a laptop, feel free to use it. If you don't have a laptop and you would like to use powerpoint or PDF, just email me the content and you can use my laptop for the presentation. Also feel free to use transparencies if you prefer, as we have an overhead projector in class.
- **Suggestions for presentation content:**
  - Name and high-level description of project
  - Why is this project interesting/fun for you?
  - What specific problems must be overcome?
  - How are you trying to overcome these problems? What prior art (e.g., algorithms from the class textbook or from published papers) are you using or building upon?
  - What is your project roadmap for the remainder of the quarter, i.e., what is your plan for what you are trying to do and by when?
  - Possibly showing preliminary results: If you already have some preliminary results that you would like to show that would be great. If not, that's fine too. Alternatively, if you have just acquired the images or video(s) which you will use in your final project then you can show them to the class.

I'm available to meet and discuss any possible projects, as well as to help you identify potential problems within the project and approaches to overcome these problems.

**Office hours:** Office hours are listed on the first page. Please feel free to stop by office hours to talk about possible projects.