

SC42025 FILTERING AND IDENTIFICATION

TURBULENCE MODELING FOR ADAPTIVE OPTICS

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December 21, 2018

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INTRODUCTION

This assignment deals with modeling an *Adaptive Optics* (AO) system in which three different data-driven turbulence modeling methods are used to achieve optimal control performances, viz.

- a random-walk process
- a Vector-Auto-Regressive model
- a stochastic state-space model

Each model has some questions associated with it, and in this assignment, we solve them in chronological sequence taking one model at a time.

RANDOM WALK MODEL

Question 1

We know from the assignment's equation (2) that:

$$s_o(k) = G\phi(k) + e(k)$$

We have the values of the wavefront sensor data in open-loop, $s_o(k)$, and also the value of the matrix G . To compute the value of $\phi(k)$, given no prior information on it, we follow the linear least-squares approach:

DO TEH GODDAMN THING HERE JUST TAKE THE NON-FULL-RANK APPROACH CUZ G AIN'T FULL RANK

content...

Question 2

We are provided with some prior information about the wavefront, viz.:

- $E[\phi(k)] = 0$
- $E[\phi(k)\phi(k)^T] = C_\phi(0)$
- noise variance = σ_e^2

Based on equation (8) from the assignment, we approximate the value of $C_\phi(0)$ as:

$$C_\phi(0) = \frac{1}{N} \sum_{i=1}^N \phi(i) \phi(i)^T$$

WE HAVE THE REQUIRED DATA NOW WE JUST NEED TO COMPUTE THE EXPRESSIONS

For questions 3 to 5, we assume $E[\epsilon(k)] = 0$ and $E[\epsilon(k)\epsilon(k)^T] = C_\phi(0)$

Question 3

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