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Courses » Estimation for Wireless Communications – MIMO/OFDM Cellular and Sensor Networks

Announcements Course Ask a Question Progress

Unit 3 - Week 2 - Vector Estimation



Course outline

How to Access the Portal ?

Week 1 - Basics of Estimation, Maximum Likelihood (ML)

Week 2 - Vector Estimation

- Lecture 06 - Estimation of Complex Parameters – Symmetric Zero Mean Complex Gaussian Noise
- Lecture 07 - Wireless Fading Channel Estimation – Pilot Symbols and Likelihood Function
- Lecture 08 - Wireless Fading Channel Estimation – Pilot Training based Maximum Likelihood ML Estimate
- Lecture 09 - Wireless Fading Channel Estimation – Mean and Variance of Pilot Training Based Channel Estimate Maximum Likelihood
- Lecture 10 - Example – Wireless Fading

Assignment-2

The due date for submitting this assignment has passed. **Due on 2017-08-06, 23:59 IST.** As per our records you have not submitted this assignment.

1) Consider the fading channel estimation problem where the output symbol $y(k)$ **1 point** is $y(k) = hx(k) + v(k)$ with $h, x(k), v(k)$ denoting the *real* channel coefficient, pilot symbol and noise sample respectively. Let $\mathbf{x} = [x(1), x(2), \dots, x(N)]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [y(1), y(2), \dots, y(N)]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and variance σ^2 . The expected value of the maximum likelihood \hat{h} is,

$\mathbf{x}^T \mathbf{y}$

$\frac{\mathbf{x}^T \mathbf{y}}{\mathbf{x}^T \mathbf{x}}$

$h\mathbf{x}^T \mathbf{y}$

h

No, the answer is incorrect.

Score: 0

Accepted Answers:

h

2) Consider the fading channel estimation problem where the output symbol $y(k)$ **1 point** is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the *real* channel coefficient, pilot symbol and noise sample respectively. Let $\mathbf{x} = [\frac{3}{2}, 1, \frac{1}{2}, -2]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [2, -\frac{1}{2}, -1, \frac{3}{2}]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance $\sigma^2 = -3dB$. The maximum likelihood estimate of the channel coefficient h is,

$\frac{1}{15}$

$\frac{2}{15}$

$-\frac{1}{15}$

$-\frac{2}{15}$

Channel Estimation for Downlink Mobile Communication

- Quiz : Assignment-2
- Assignment-2 Solution

Week 3 - Cramer-Rao Bound (CRB), Vector Parameter Estimation, Multi-Antenna Downlink Mobile Channel Estimation

Week 4 - Least Squares (LS) Principle, Pseudo-Inverse, Properties of LS Estimate, Examples - Multi-Antenna Downlink and MIMO Channel Estimation

Week 5 - Inter Symbol Interference, Channel Equalization, Zero-forcing equalizer, Approximation error of equalizer

Week 6 - Introduction to Orthogonal Frequency Division Multiplexing (OFDM) and Pilot Based OFDM Channel Estimation, Example

Week 7 - OFDM - Comb Type Pilot (CTP) Transmission, Channel Estimation in Time/ Frequency Domain, CTP Example, Frequency Domain Equalization (FDE), Example-FDE

Week 8 - Sequential Least Squares (SLS) Estimation - Scalar/ Vector

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$-\frac{2}{15}$$

3) Consider the fading channel estimation problem where the output symbol $y(k)$ is **1 point** $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the *real* channel coefficient, pilot symbol and noise sample respectively. Let $\mathbf{x} = [\frac{3}{2}, 1, \frac{1}{2}, -2]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [2, -\frac{1}{2}, -1, \frac{3}{2}]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance $\sigma^2 = -3dB$. The variance of the maximum likelihood estimate of the channel coefficient h is,



$$\frac{1}{15}$$



$$\frac{2}{15}$$



$$\frac{3}{15}$$



$$\frac{4}{15}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{1}{15}$$

4) Consider the fading channel estimation problem where the output symbol $y(k)$ **1 point** is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the *complex* channel coefficient, pilot symbol and noise sample respectively. Let $\mathbf{x} = [1 - 2j \quad 2 + j \quad 1 - j \quad 2 - j]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [1 - j \quad -1 + 2j \quad 1 \quad 1 - 2j]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance $\sigma^2 = -9dB$. The maximum likelihood estimate of the channel coefficient h is,



$$\frac{6}{17}j$$



$$\frac{8}{17} + \frac{4}{17}j$$



$$-\frac{4}{17} - \frac{6}{17}j$$



$$\frac{8}{17} - \frac{4}{17}j$$

No, the answer is incorrect.

Score: 0

Feedback:

Accepted Answers:

$$\frac{8}{17} + \frac{4}{17}j$$

5) Consider the fading channel estimation problem where the output symbol $y(k)$ **1 point** is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the *complex* channel coefficient, pilot symbol and noise sample respectively. Let

$\mathbf{x} = [1 - 2j \quad 2 + j \quad 1 - j \quad 2 - j]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [1 - j \quad -1 + 2j \quad 1 \quad 1 - 2j]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance



Cases,
Applications -
Wireless Fading
Channel
Estimation, SLS
Example

$\sigma^2 = -9dB$. The variance of the maximum likelihood estimate of the channel coefficient h is,

- $\frac{1}{120}$
- $\frac{1}{136}$
- $\frac{1}{150}$
- $\frac{1}{196}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\frac{1}{136}$

6) Consider the fading channel estimation problem where the output symbol $y(k)$ is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the complex channel coefficient, pilot symbol and noise sample respectively. Let

$\mathbf{x} = [1 - 2j \quad 2 + j \quad 1 - j \quad 2 - j]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [1 - j \quad -1 + 2j \quad 1 \quad 1 - 2j]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance $\sigma^2 = -9dB$. The variance of the real part of the maximum likelihood \hat{h} is,

- $\frac{1}{240}$
- $\frac{1}{196}$
- $\frac{1}{272}$
- $\frac{1}{75}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\frac{1}{272}$

7) Consider the fading channel estimation problem where the output symbol $y(k)$ is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the complex channel coefficient, pilot symbol and noise sample respectively. Let

$\mathbf{x} = [1 - 2j \quad 2 + j \quad 1 - j \quad 2 - j]^T$ denote the pilot vector of transmitted pilot symbols and $\mathbf{y} = [1 - j \quad -1 + 2j \quad 1 \quad 1 - 2j]^T$ denote the corresponding received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance $\sigma^2 = -9dB$. The variance of the imaginary part of the maximum likelihood \hat{h} is,

- $\frac{1}{272}$
- $\frac{1}{300}$
- $\frac{1}{75}$
- $\frac{1}{392}$



No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{1}{272}$$

8) Consider the fading channel estimation problem where the output symbol $y(k)$ is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the complex channel coefficient, pilot symbol and noise sample respectively. Let

$\mathbf{x} = [1 - 2j \quad 2 + j \quad 1 - j \quad 2 - j]^T$ denote the pilot vector of transmitted pilot

symbols and $\mathbf{y} = [1 - j \quad -1 + 2j \quad 1 \quad 1 - 2j]^T$ denote the corresponding

received symbol vector. Let $v(k)$ be IID Gaussian noise with zero-mean and dB variance

$\sigma^2 = -9dB$. The errors in the real and imaginary parts of the maximum likelihood \hat{h} are

- Equal
- Correlated
- Independent
- All of the above

No, the answer is incorrect.

Score: 0

Accepted Answers:

Independent

9) Consider the fading channel estimation problem where the output symbol $y(k)$ is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the real channel coefficient, pilot

symbol and noise sample respectively. Let $\mathbf{x} = [x(1), x(2), \dots, x(N)]^T$ denote the pilot

vector of transmitted pilot symbols and $\mathbf{y} = [y(1), y(2), \dots, y(N)]^T$ denote the

corresponding received symbol vector. Let $v(k)$ be independent Gaussian noise with zero-

mean and variance $k\sigma^2$. And let \mathbf{R} denote the covariance matrix of the noise vector

$\mathbf{v} = [v(1), v(2), \dots, v(N)]^T$. The ML estimate of the channel coefficient is,

$$\hat{h} = \frac{1}{N} \sum_{k=1}^N \frac{y(k)}{k}$$

$$\frac{\mathbf{x}^T \mathbf{y}}{\mathbf{x}^T \mathbf{x}}$$

$$\mathbf{x}^T \mathbf{R}^{-1} \mathbf{y}$$

$$\hat{h} = \frac{\sum_{k=1}^N \frac{x(k)y(k)}{k}}{\sum_{k=1}^N \frac{x^2(k)}{k}}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\hat{h} = \frac{\sum_{k=1}^N \frac{x(k)y(k)}{k}}{\sum_{k=1}^N \frac{x^2(k)}{k}}$$

10) Consider the fading channel estimation problem where the output symbol $y(k)$ is $y(k) = hx(k) + v(k)$, with $h, x(k), v(k)$ denoting the real channel coefficient, pilot

symbol and noise sample respectively. Let $\mathbf{x} = [x(1), x(2), \dots, x(N)]^T$ denote the pilot

vector of transmitted pilot symbols and $\mathbf{y} = [y(1), y(2), \dots, y(N)]^T$ denote the

corresponding received symbol vector. Let $v(k)$ be independent Gaussian noise with zero-

mean and variance $k\sigma^2$. And let \mathbf{R} denote the covariance matrix of the noise vector

$\mathbf{v} = [v(1), v(2), \dots, v(N)]^T$. The variance of the ML estimate of the channel coefficient is,

$$\frac{\sigma^2}{\|x^2\|}$$

$$\frac{1}{x^T \mathbf{R}^{-1} x}$$

$$\frac{\sigma^2}{\sum_{k=1}^N k|x(k)|^2}$$

$$\frac{\sigma^2}{N}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{1}{x^T \mathbf{R}^{-1} x}$$



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