

Centralized State Estimation of Distributed Maritime Autonomous Surface Oceanographers

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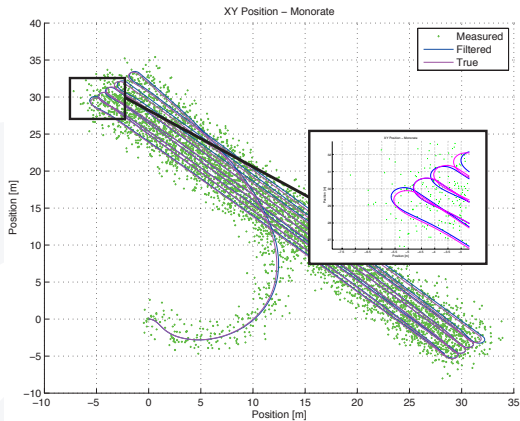
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Kalman filter

Monorate implementation

First iteration of the Kalman filter design was a monorate variant. This produced the following results:



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Results

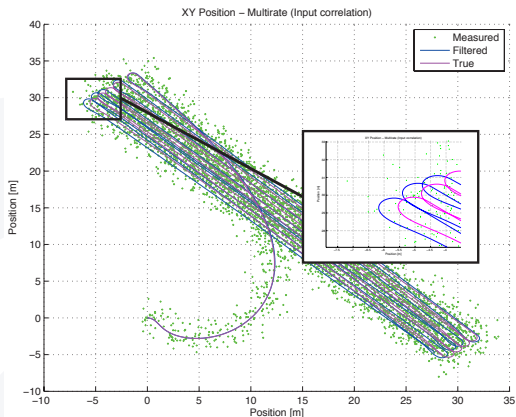
2 Kalman filter

Packet loss
AAUSHIP.01

Kalman filter

Multirate & input holding

- The realistic case, using different sampling frequencies
- It holds the last GPS position when it does not receive an update



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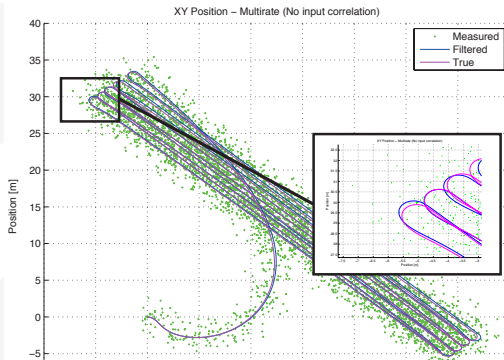
Kalman filter

Multirate & input mask

The final version: the input mask $\mathbf{\Lambda}$ sets the Kalman gain to 0 for invalid inputs.

$$\mathbf{\Lambda} = \text{diag}\{\lambda_x, \lambda_{\dot{x}}, \lambda_{\ddot{x}}, \lambda_{\lambda_y}, \lambda_{\dot{y}}, \lambda_{\ddot{y}}, \lambda_{\theta}, \lambda_{\omega}, \lambda_{\alpha}\}, \quad \lambda = \begin{cases} 1, & \text{valid} \\ 0, & \text{invalid} \end{cases}$$

$$\bar{\mathbf{K}} = \mathbf{K}\mathbf{\Lambda}$$



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Packet loss

Considerations

- We have a simplex communication link

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Packet loss

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Packet loss

Considerations

- ▶ We have a simplex communication link
- ▶ It does not guarantee packet arrival or integrity

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Packet loss

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Packet loss

Considerations

- ▶ We have a simplex communication link
- ▶ It does not guarantee packet arrival or integrity
- ▶ It implements a CRC so we can detect errors

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Packet loss

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Considerations

- ▶ We have a simplex communication link
- ▶ It does not guarantee packet arrival or integrity
- ▶ It implements a CRC so we can detect errors
- ▶ We take advantage of the Kalman filter state estimation

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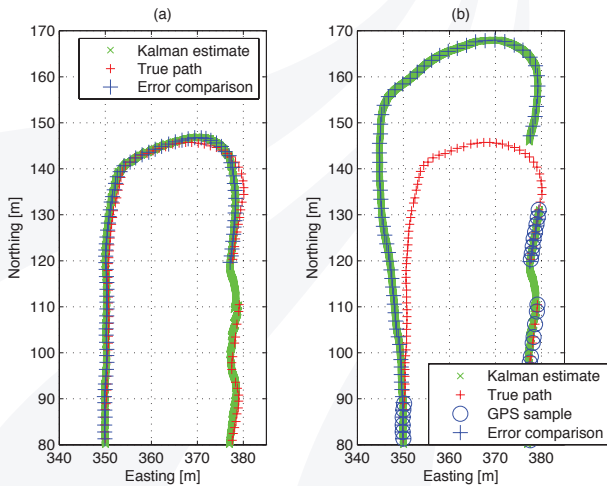
Packet loss

AAUSHIP.01

Packet loss

Simulation Results

- Even with and enormously exaggerated packet loss of 100% for 60 seconds, the Kalman filter still gives a relatively good approximation:



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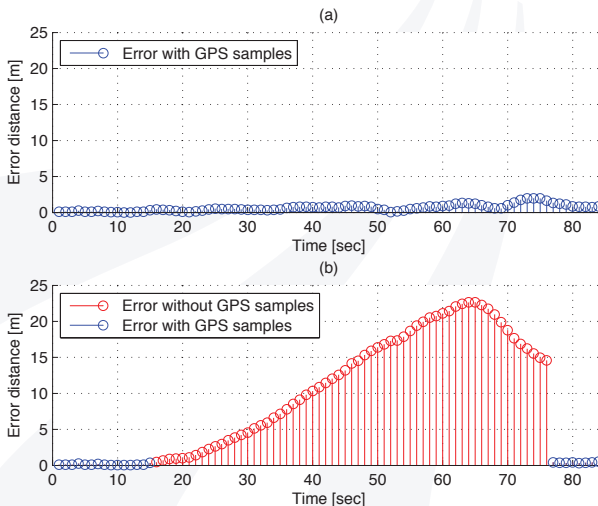
Packet loss

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Packet loss

Simulation Results

- As can be seen the peak error is around 23 m.



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Ship development

- ▶ During the project a ship was developed, using 3D modeling and rapid prototyping.
- ▶ The ship is developed as a non-planing displacement hull.

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