UNIVERSITÀ DEGLI STUDI DI PADOVA
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
Laurea magistrale in Ingegneria dell'Automazione

Control and Guidance Systems for the Navigation of a Biomimetic Autonomous Underwater Vehicle

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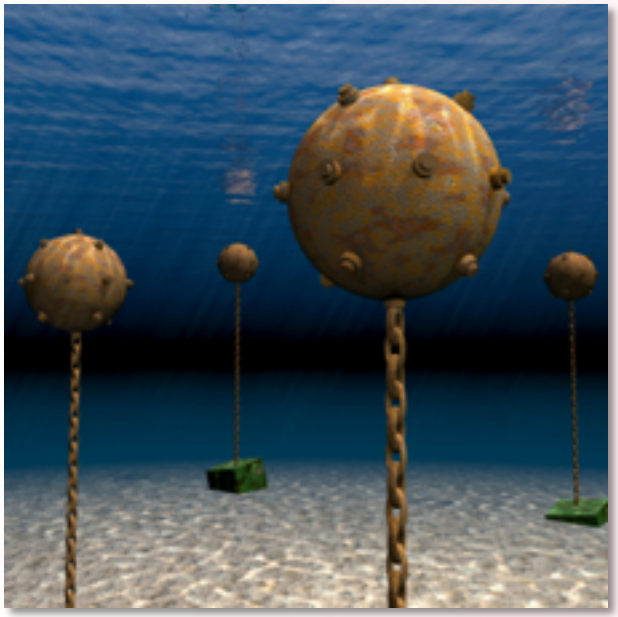
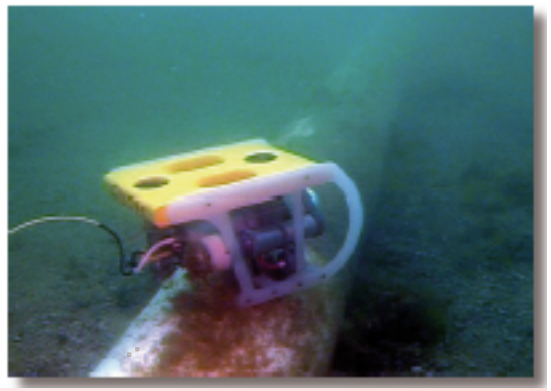
Applications

- pipeline inspection
- deep sea exploration
- mines clearing operations
- biological studies





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State of Art

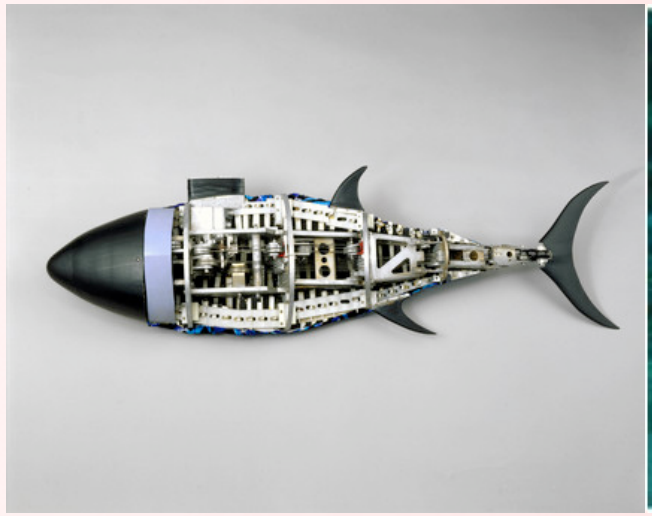
AUVs

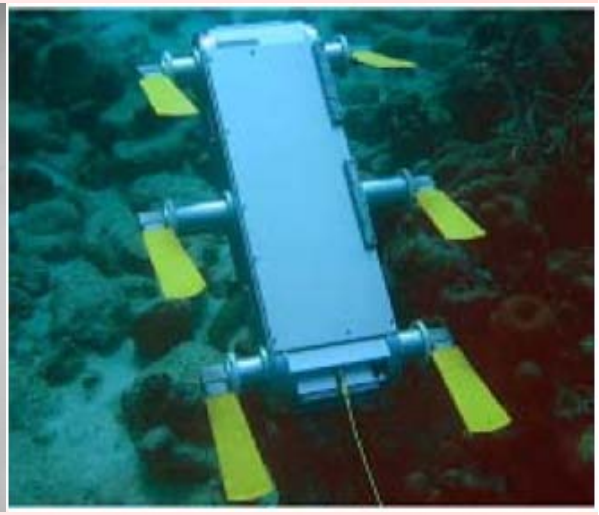
Traditional

Biomimetic

BCF

PMF





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Open Issues

Limiting factors:

- Limitation of battery power
  - → Biomimetic propulsion

- Autonomous operation
  - → Navigation, guidance and control systems

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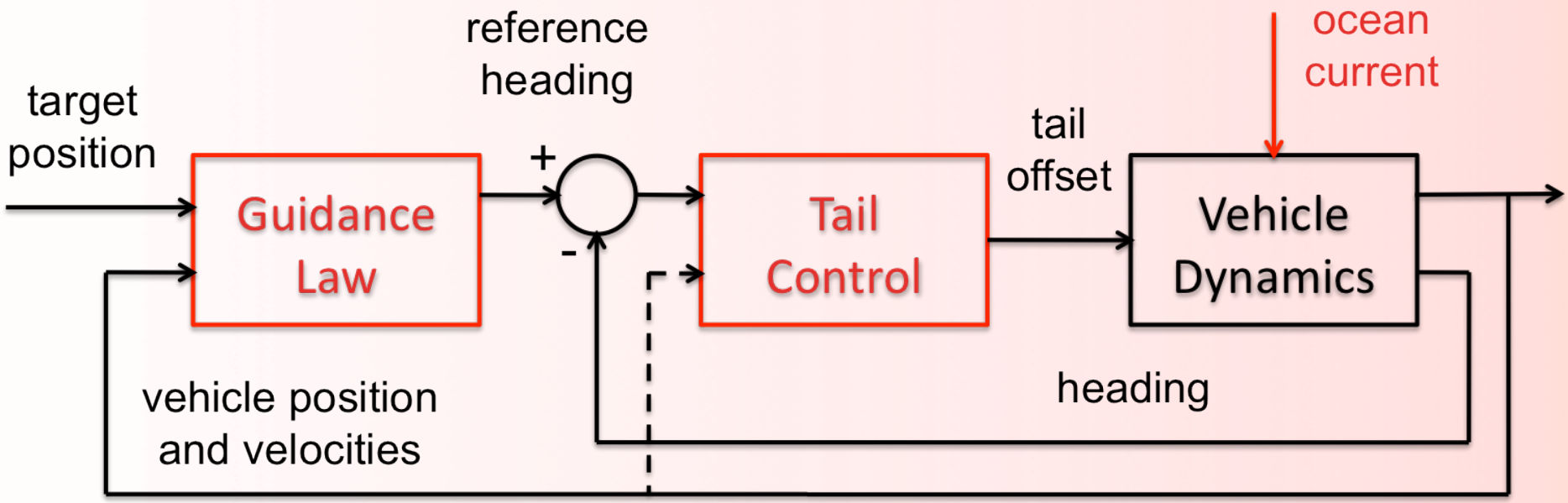
Contribution

- control system design
- guidance system design → RoboSalmon AUV
- analysis of ocean current



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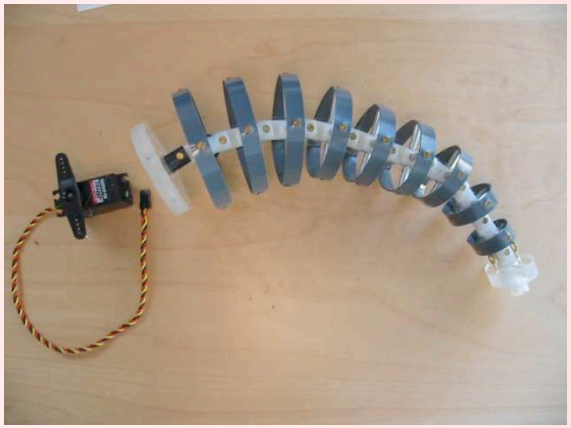
The RoboSalmon

- Morphology:
  - 0.85 m in length
  - 4.88 kg in weights
  - sub-carrangiform swimming mode

- Propulsion System:
  - Single actuated ten joints tail



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Mathematical Model

- Dynamics:

Inertia matrix

Coriolis and centripetal matrix

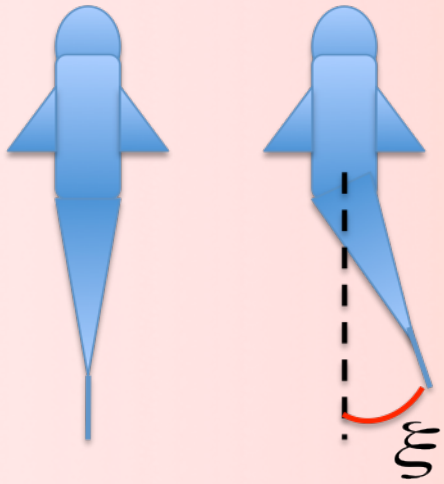
Damping matrix

Gravitational forces and moments vector

$$M\dot{\nu} + C(\nu)\nu + D(\nu)\nu + g(\eta) = \tau$$

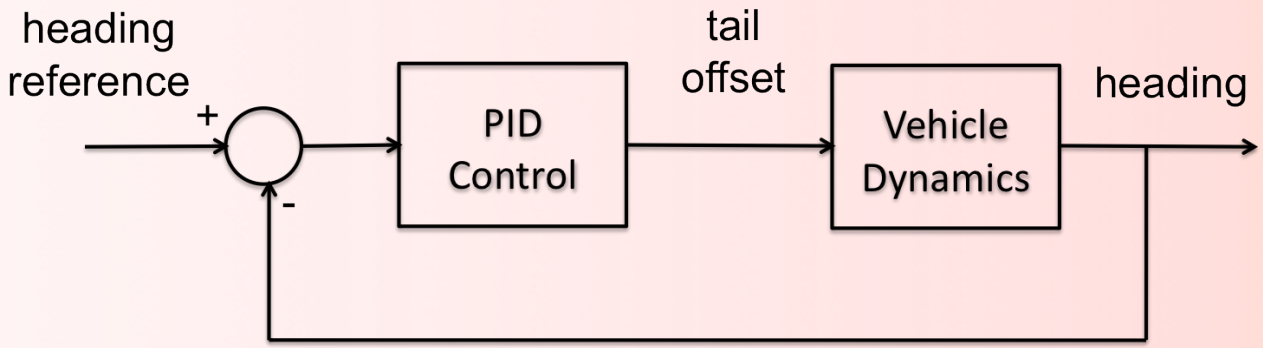
- Control vector:

$$\tau = \tau(t,\xi) \rightarrow \begin{cases} \tau(t+T,\xi) = \tau(t,\xi) \\ \int_{t_0}^{t_0+T} \tau(t,\xi)dt = \bar{\tau}(\xi) \end{cases}$$

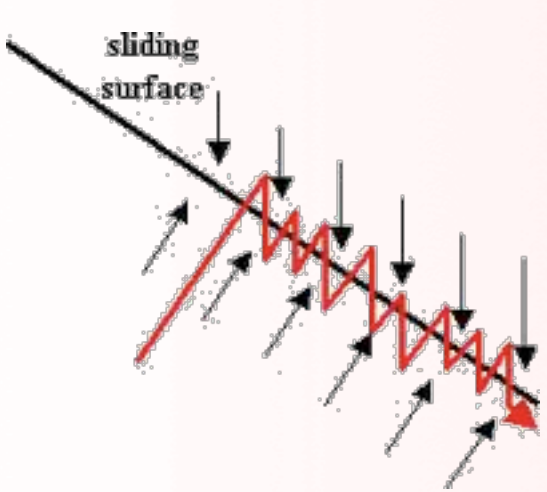


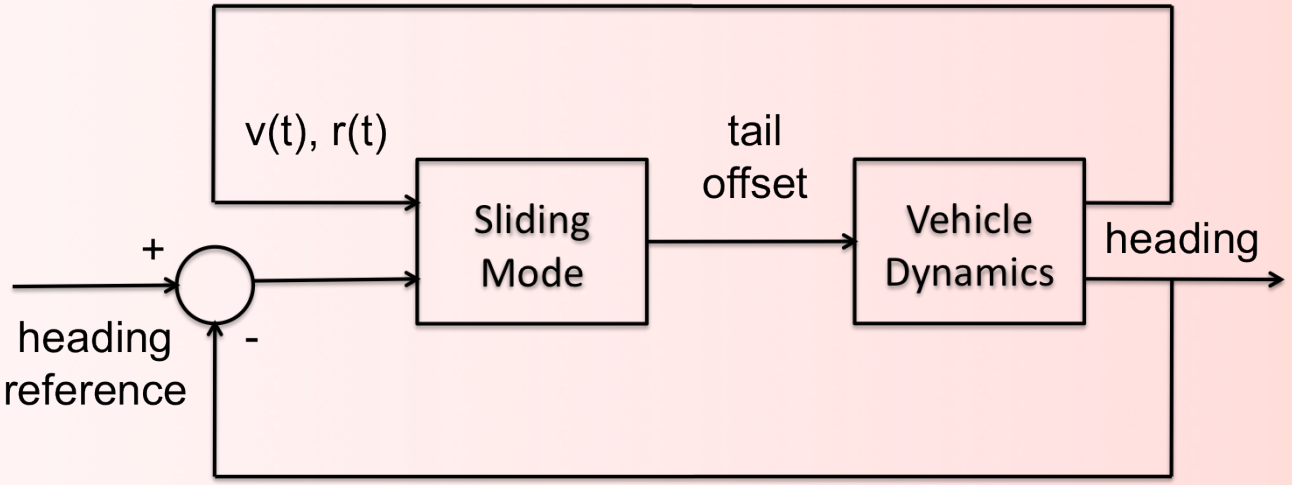
Heading Control Systems

- PID Algorythm:



- Sliding Mode Control:



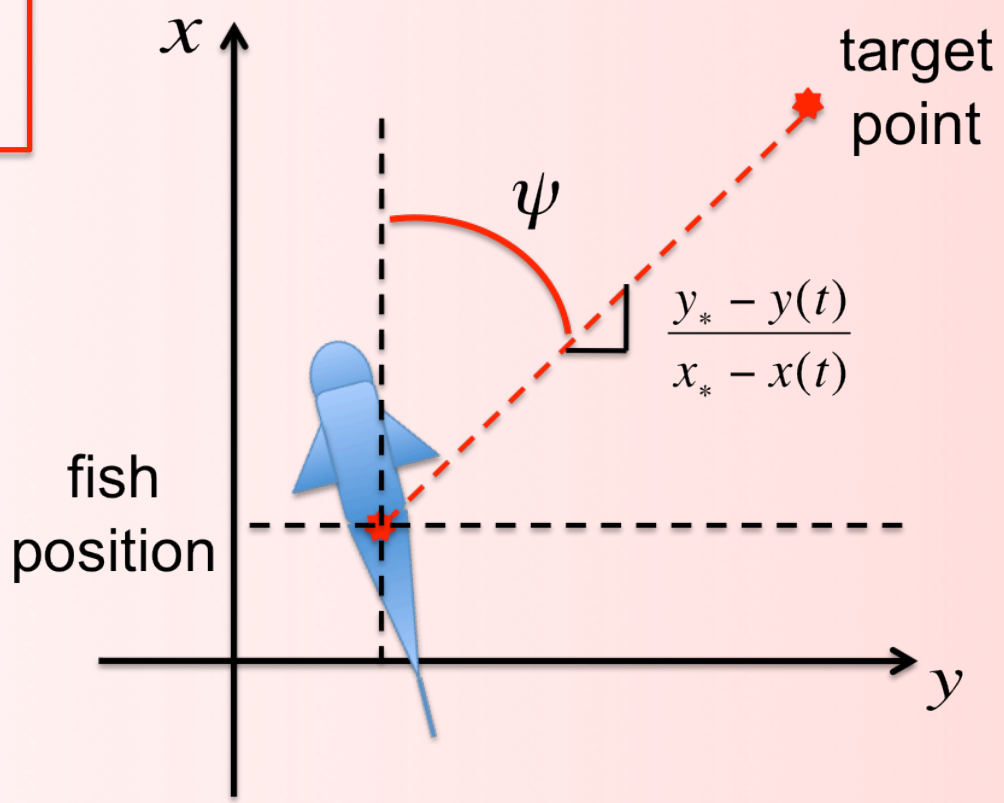


Guidance Law

Line of Sight Guidance Law:

$$\psi = \tan^{-1}\left(\frac{y_* - y(t)}{x_* - x(t)}\right)$$

waypoint guidance



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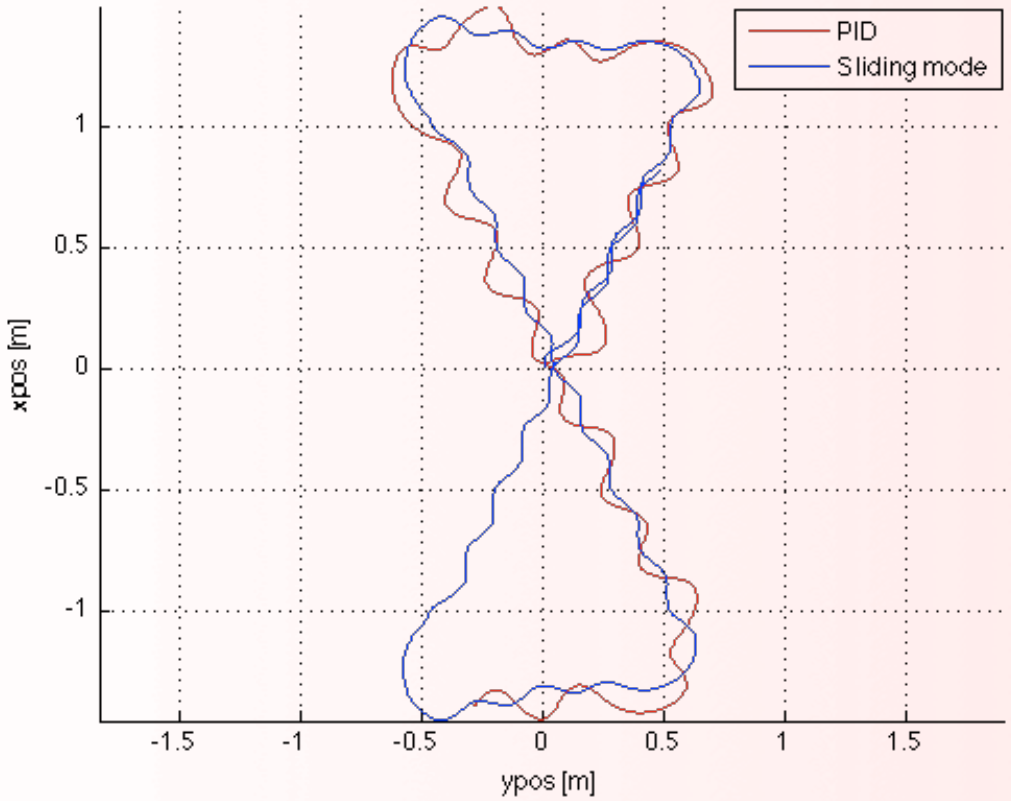
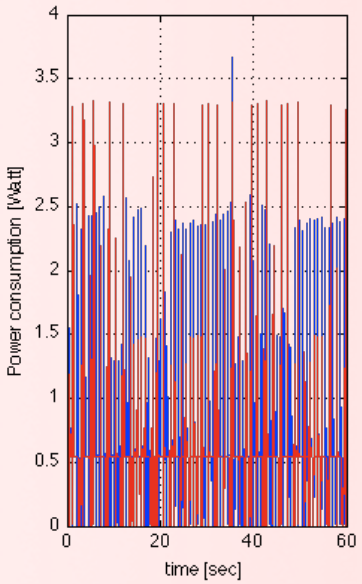
Comparison

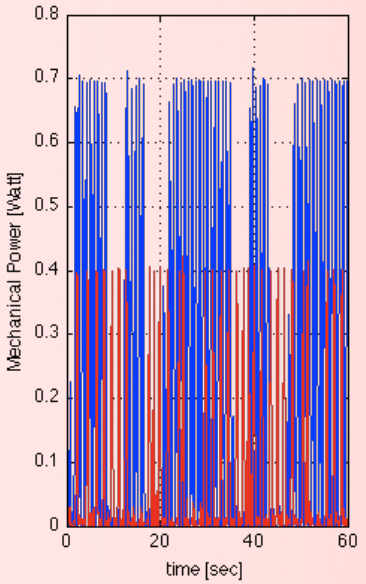


Powers:

electrical



mechanical



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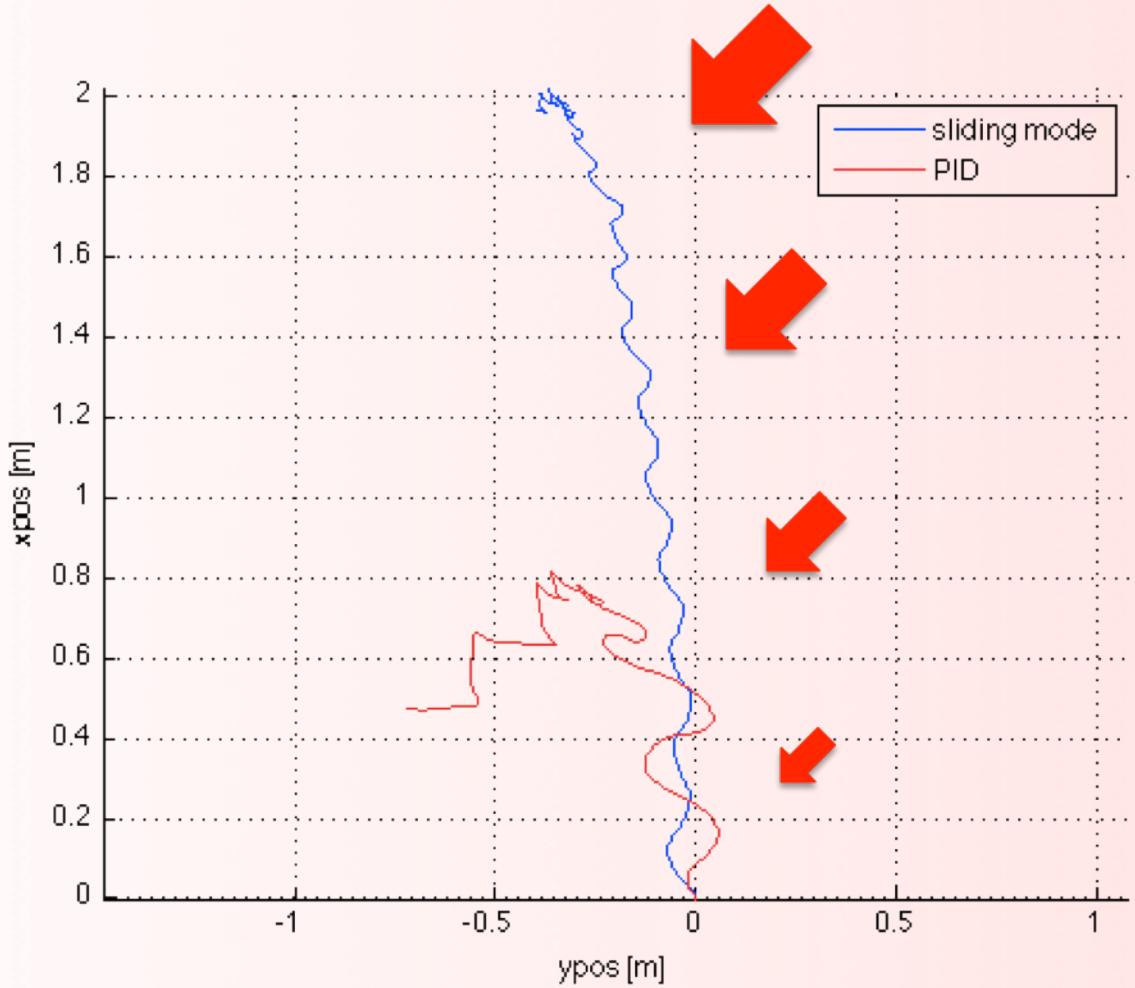
Ocean Current Disturbances



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Conclusions

- Conclusion:
  - Suitable control and guidance systems
  - Sliding mode guarantees better performances

- Future work:
  - Change the mechanic of the tail propulsion system
  - More advanced control systems

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Grazie per l’attenzione