Dynamic modelling of a screw actuator for improved locomotion control on various terrains

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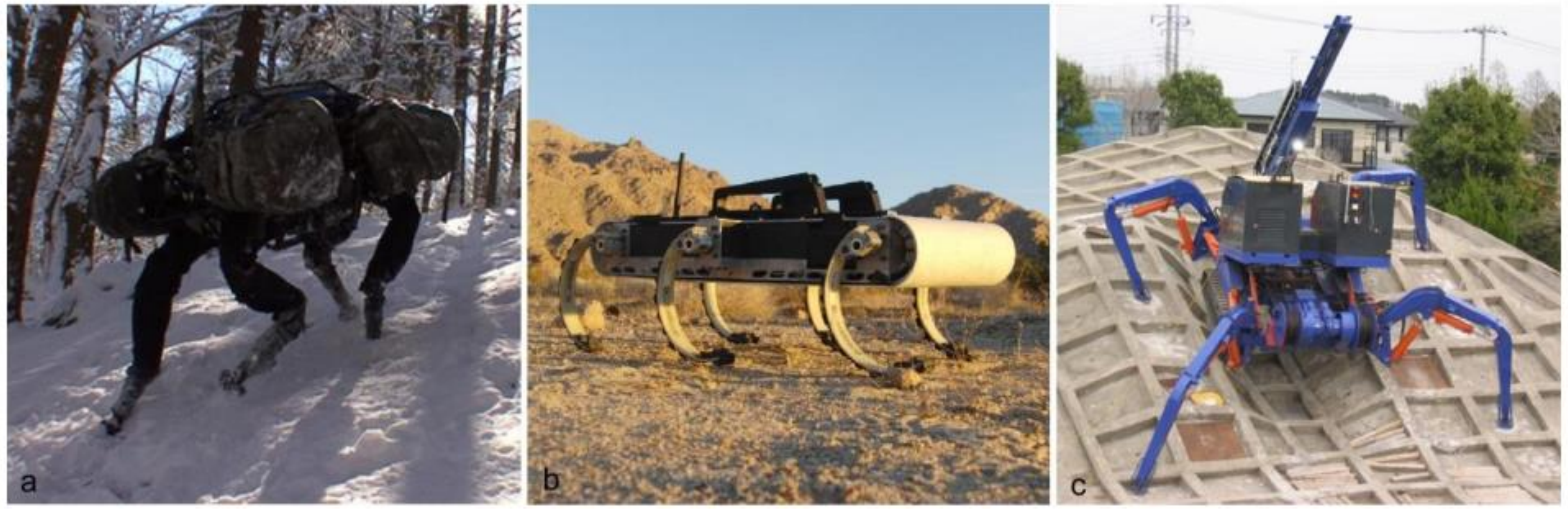
Outline of the presentation:

- Context and Problem formulation
- Methodology & Experimental setup
- Results
- Conclusion & Future work

Sharing is encouraged

Locomotion in unstructured environments



Legged robots: BigDog (a, Playter et al., 2006), RHex (b, Altendorfer et al., 2001), Titan XI (c, Hodoshima et al., 2007).

Tracked robots: Nanokhod (a, Klinker et al., 2007), Robhaz DT3 (b, Woosub et al., 2004) and Gunryu (c, Hirose et al., 1996).

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Locomotion in unstructured environments

ROBOMINER RM3 prototype

How to model a robot with screw actuators?

Importance:
- **Pose estimation**
- **Control**
- **Simulations**

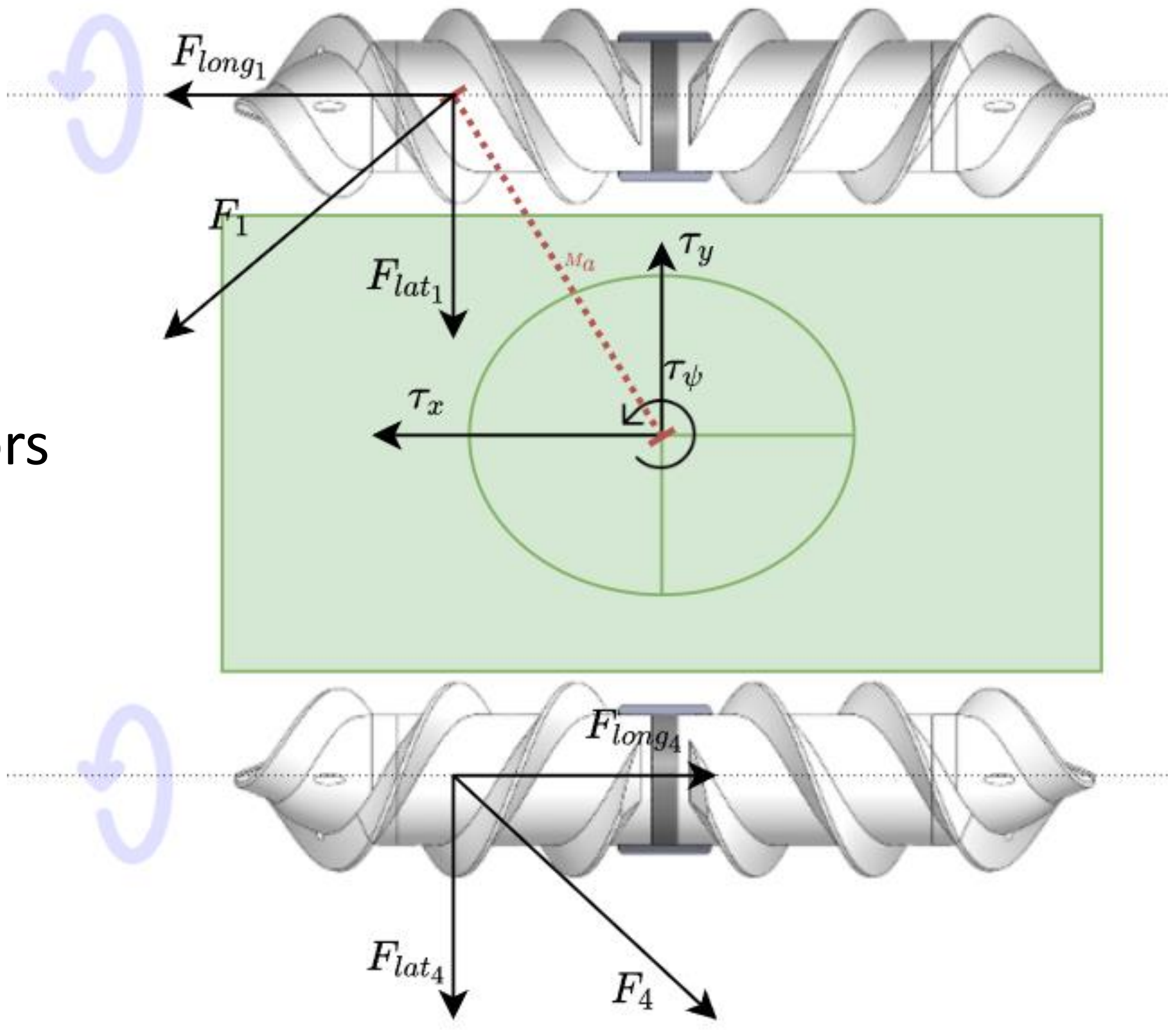
Methodology & Experimental setup

η: $[x, y, z, \phi, \theta, \psi]^T$
ν: $[u, v, w, p, q, r]$

τ: $[\tau_x, \tau_y, \tau_z, \tau_\phi, \tau_\theta, \tau_\psi]^T$

$$\dot{\boldsymbol{\eta}} = J(\boldsymbol{\nu})\boldsymbol{\nu}$$
$$\dot{\boldsymbol{\nu}} = M^{-1}(-g(\boldsymbol{\eta}) - D(\boldsymbol{\nu}) + \boldsymbol{\tau})$$
$$\boldsymbol{\tau} = \boldsymbol{\alpha}\, B\, \Omega$$

To identify $\boldsymbol{\alpha}$ and $\boldsymbol{D}$:
We use two Simple Linear Regressors
$Y = X\Theta + \epsilon$



- ■ : Known
- ■ : Measured
- ■ : To be identified

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Methodology & Experimental setup

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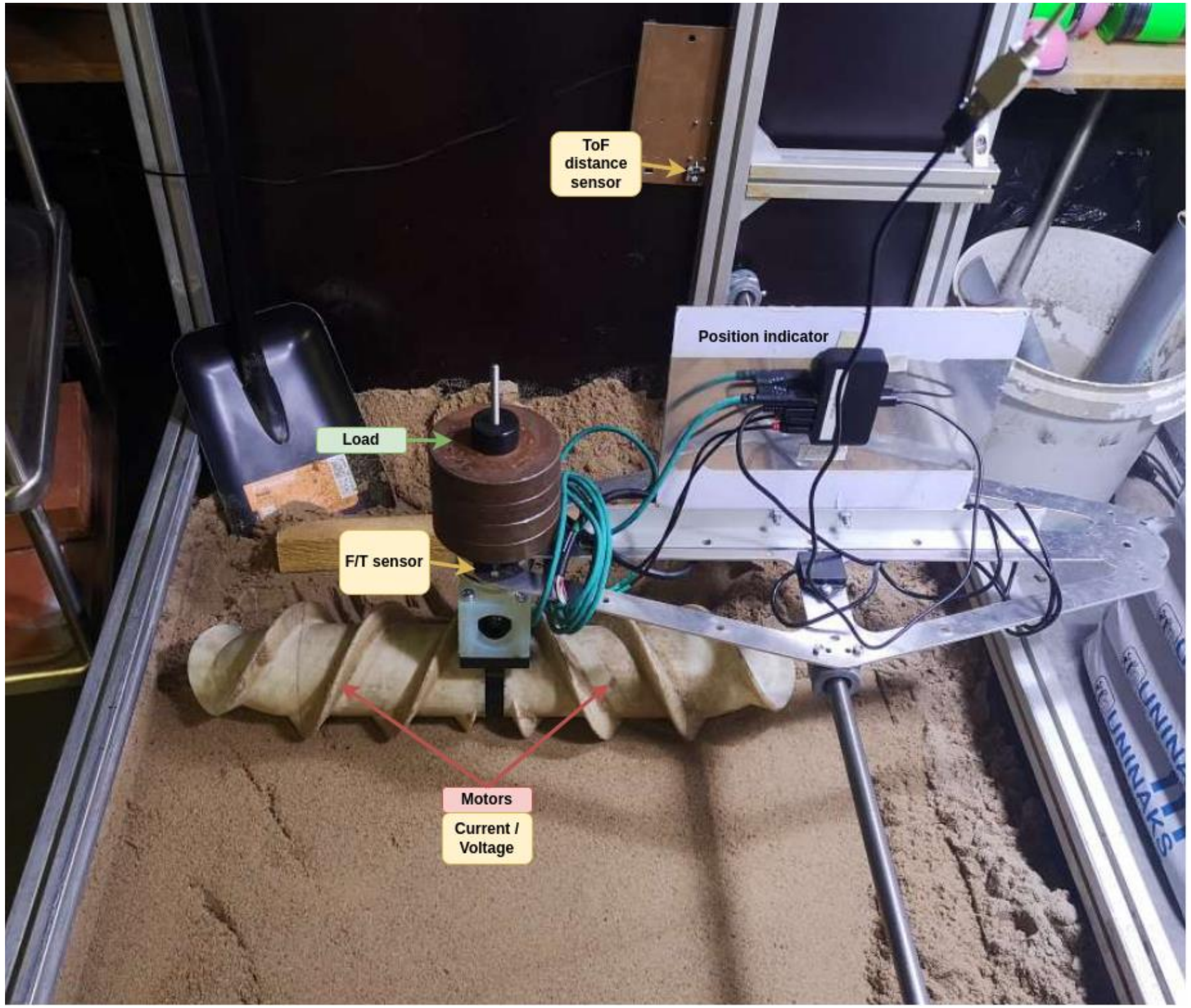
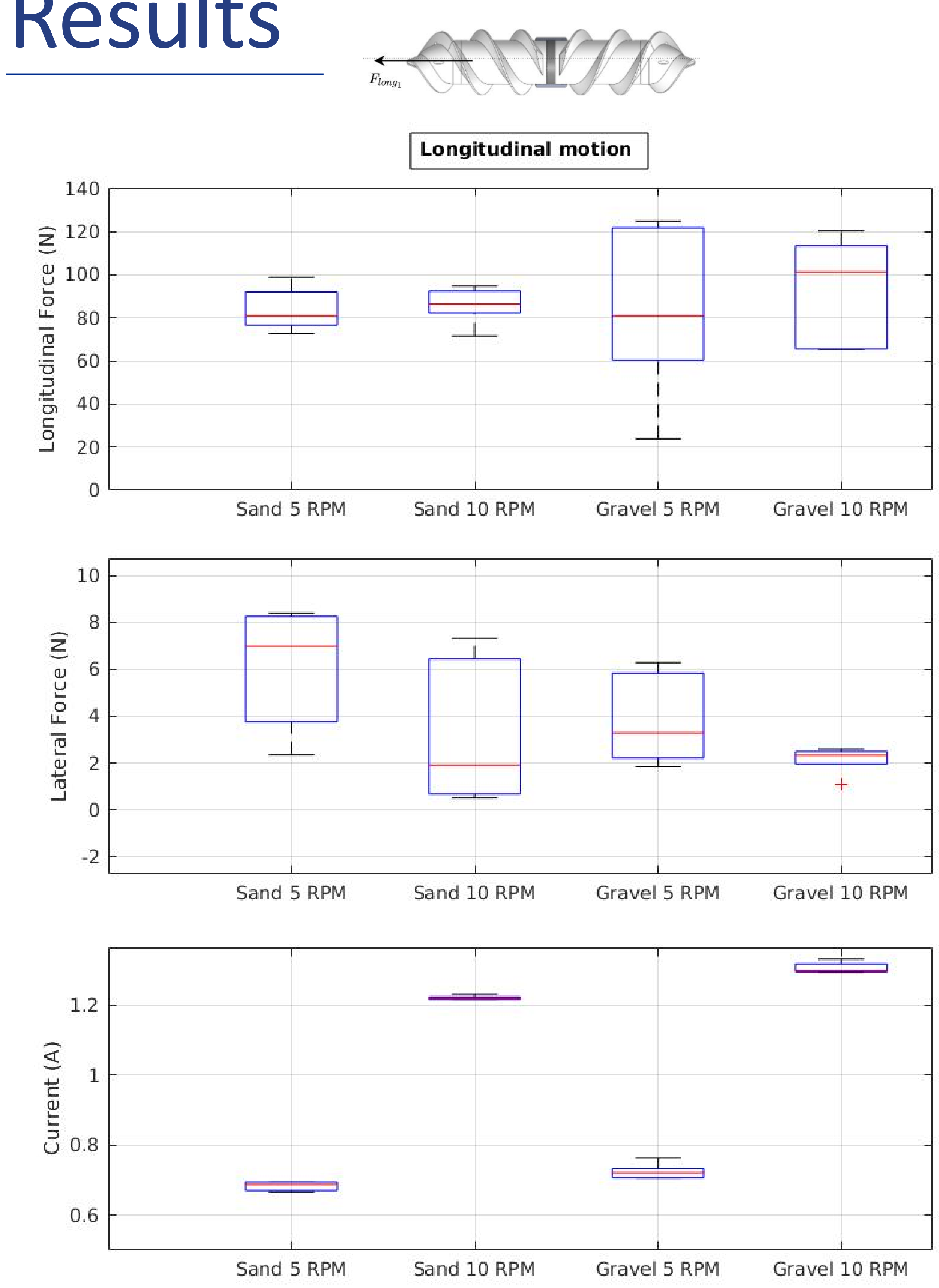
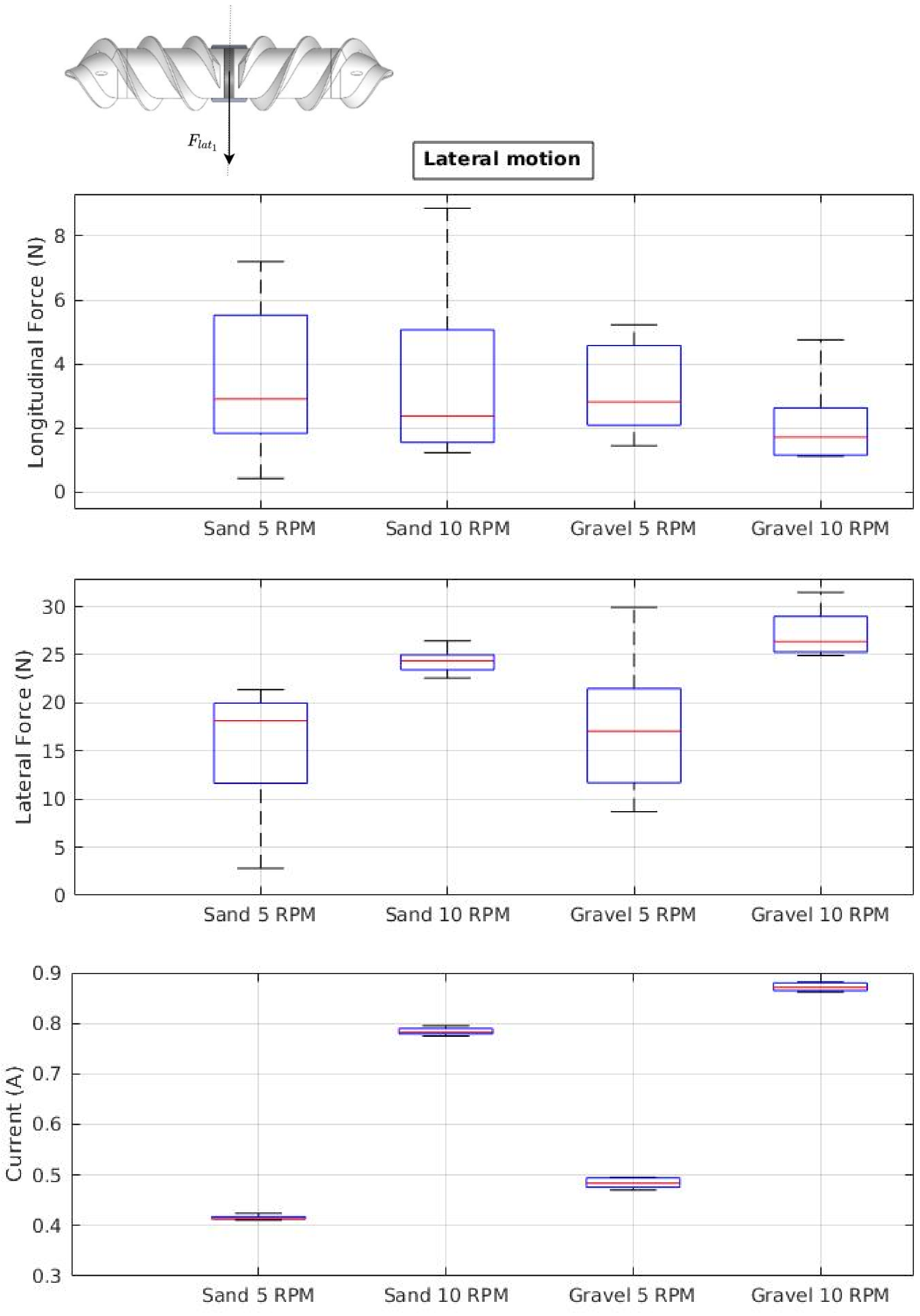


Results





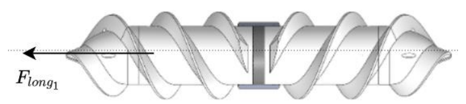
η: $[x, y, z, \phi, \theta, \psi]^T$
$\nu = [u, v, w, p, q, r]$

τ: $[\tau_x, \tau_y, \tau_z, \tau_\phi, \tau_\theta, \tau_\psi]^T$

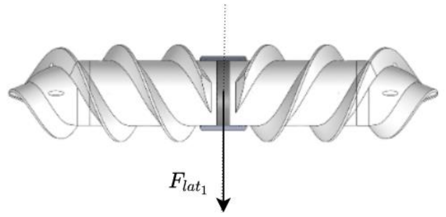
$$\dot{\eta} = J(\nu)\nu$$
$$\dot{\nu} = M^{-1}(-g(\eta) - D(\nu) + \tau)$$
$$\tau = \alpha B\, F$$

- ■ : Known
- ■ : Measured
- ■ : To be identified

Results



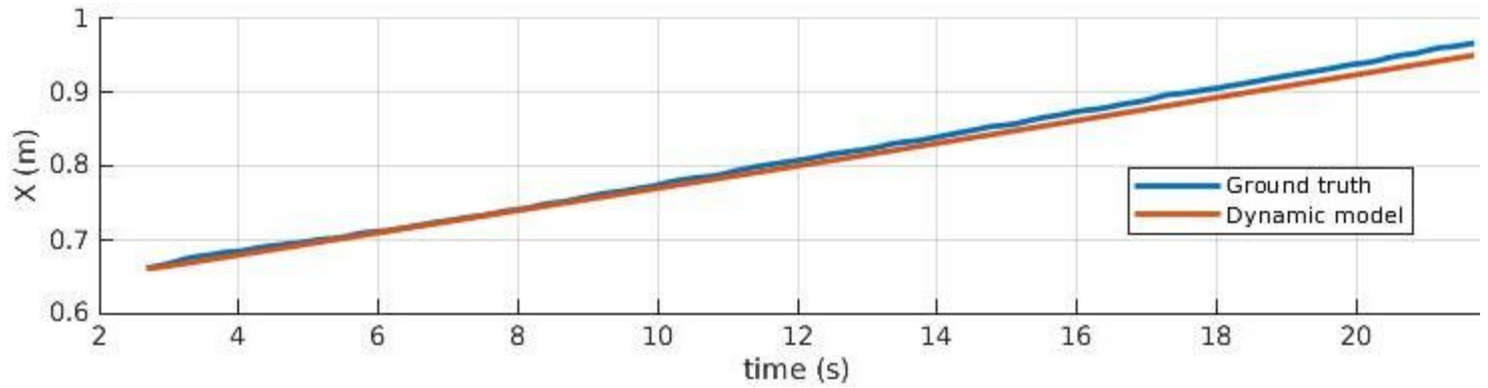
Longitudinal motion

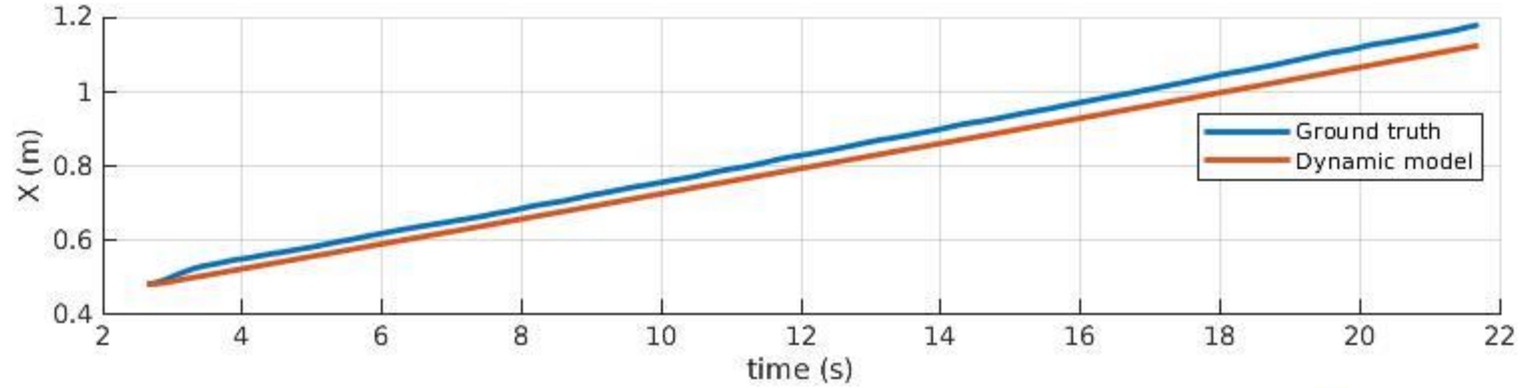


Lateral motion

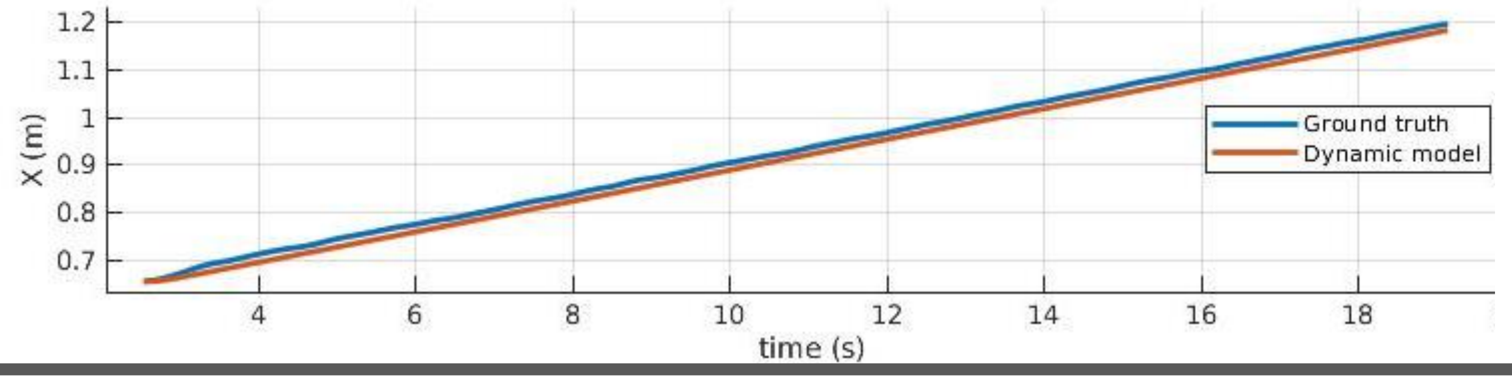
Sand

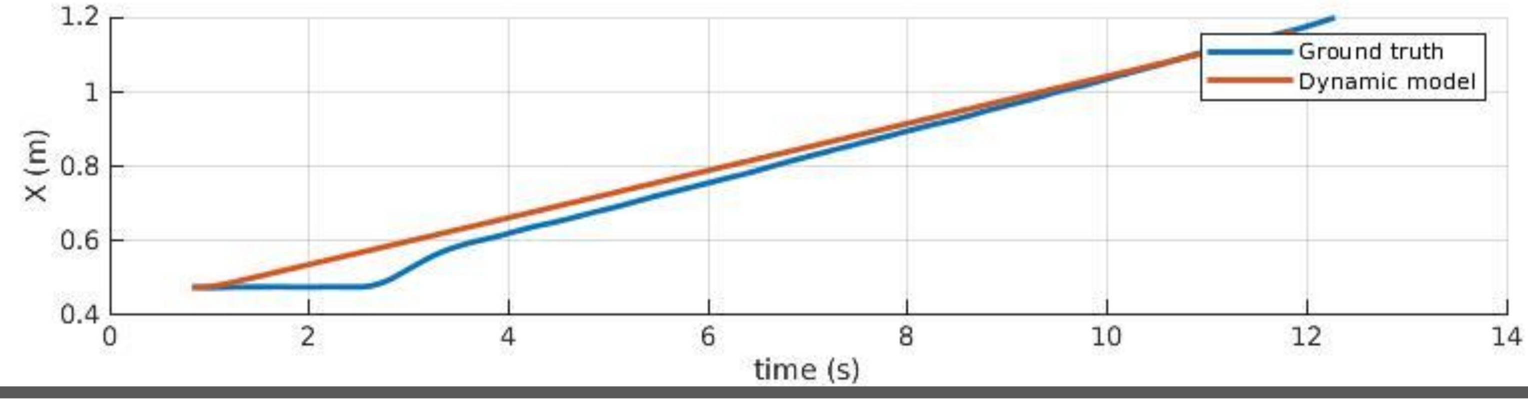
5 RPM





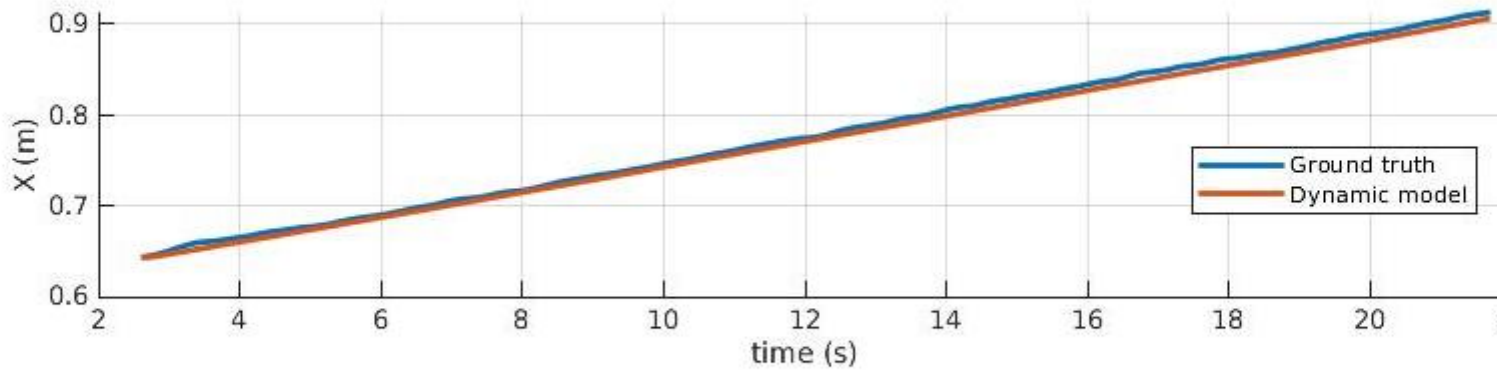
10 RPM

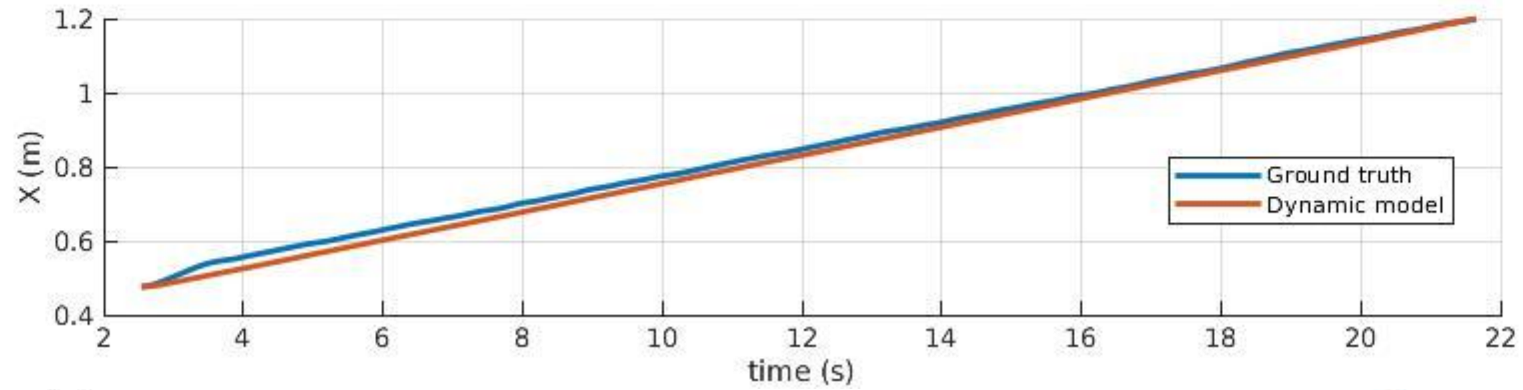




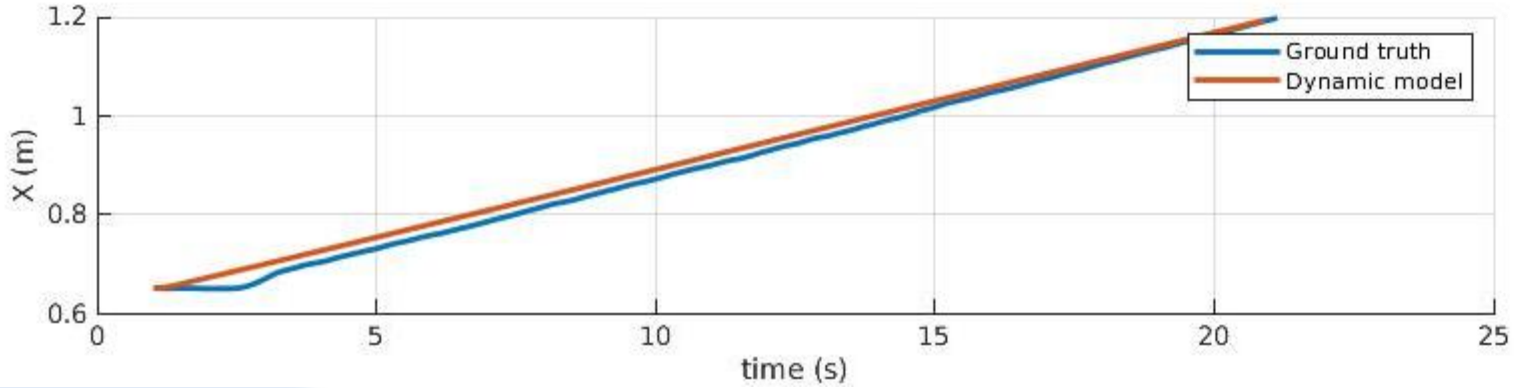
Gravel

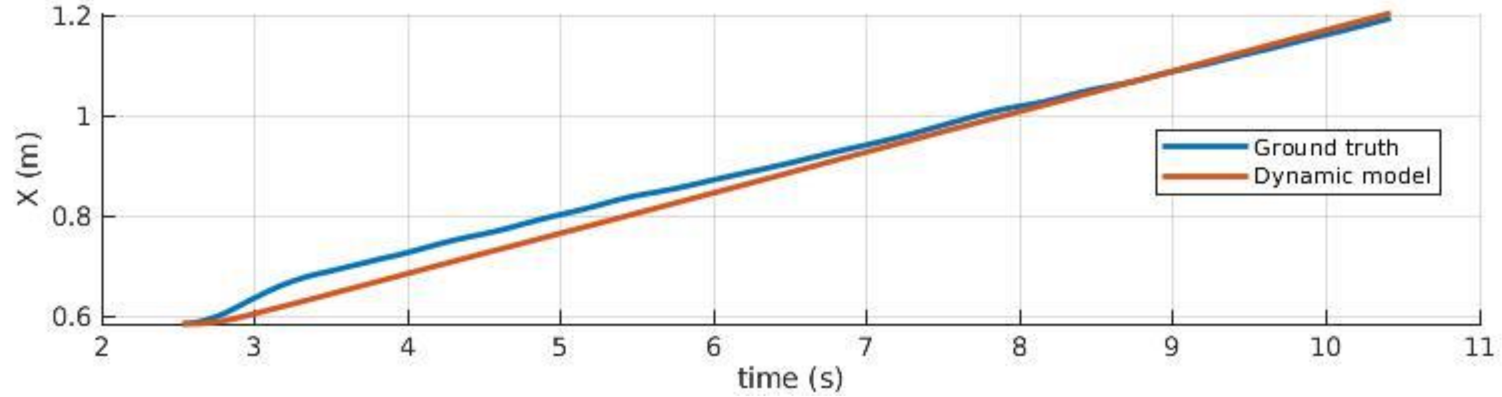
5 RPM



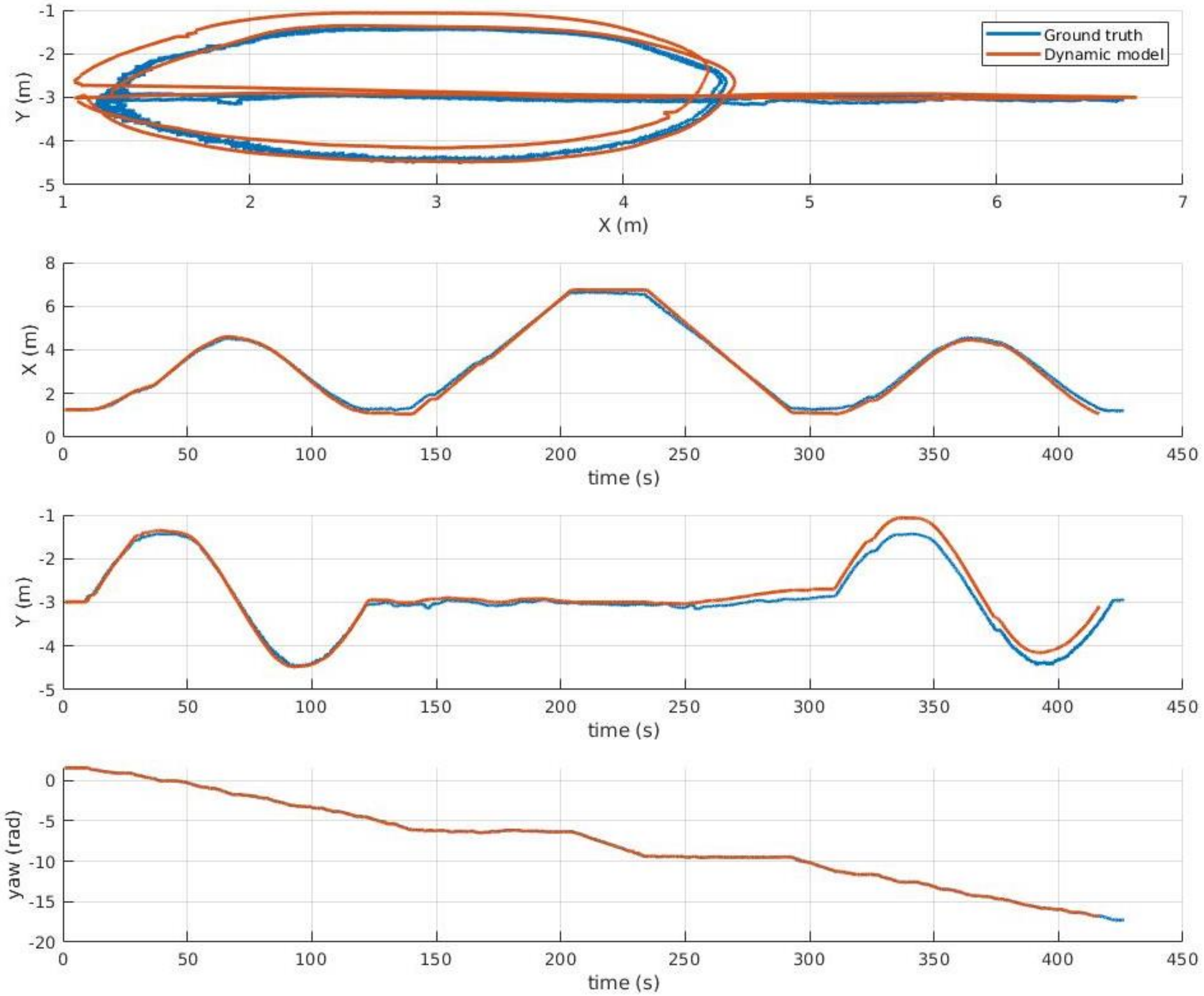


10 RPM





Results


Ground truth
Dynamic model
Y (m)
X (m)
X (m)
time (s)
Y (m)
time (s)
yaw (rad)
time (s)

Sharing is encouraged

Conclusions & Future work

The proposed model can be used to:

- Estimate the robot's pose.
- Design Model-based controllers.
- Develop simulation frameworks.

Future perspectives:

- Online model identification.
- Include slip detection.
- Develop adaptive closed-loop controllers.

Thank you for your attention!

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