Informatics

Building a Sandbox Towards Investigating the Behaviour of Control Algorithms and Training of Real-World Robots

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Motivation and Problem Statement

- Robot control is still challenging and complex.
- Machine learning approaches already work well in simulation.
- When deployed on real robot, results sometimes not satisfying
- „Reality gap“: Discrepancy between simulation and reality
- Unknown where and how big differences between simulation and reality are
- Training of robots requires large amount of training data.

Aim of the Work

Development of a sandbox that offers:

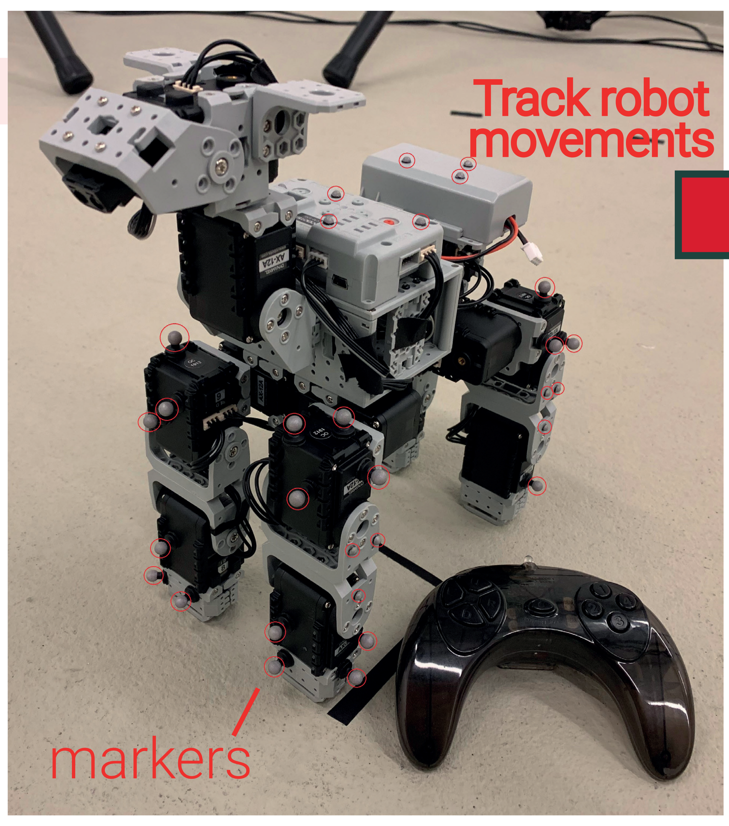
- experimentation with robots
- exploration and observation of robot motion
- continuous data collection, e.g. position and joint angles of robots
- insight into the behaviour of simulation models and real robots

Required Components

- Optical motion capture system for robot observation and data collection
- Simulation tool for generating artificial motion data for a virtual robot model and for comparison of real-world and simulated data
- A robot of interest

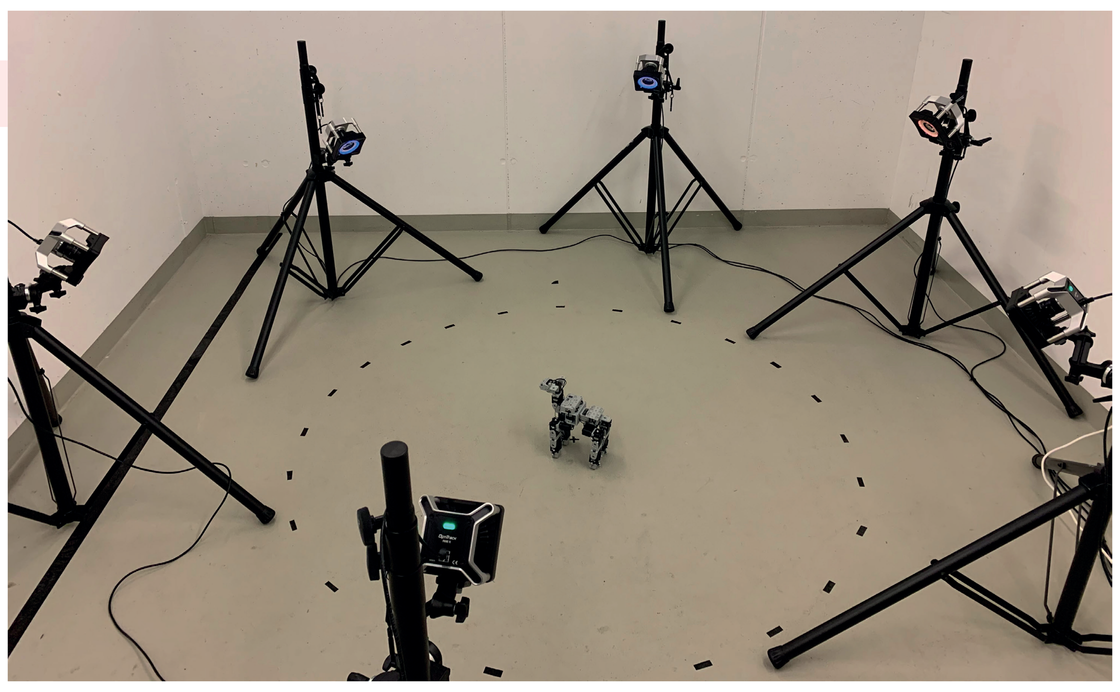
Robot

- from ROBOTIS
- 15 degrees of freedom (DOF)
- Actuated by servomotors
- Motion defined by joint angles and moving speed
- Controlled remotely

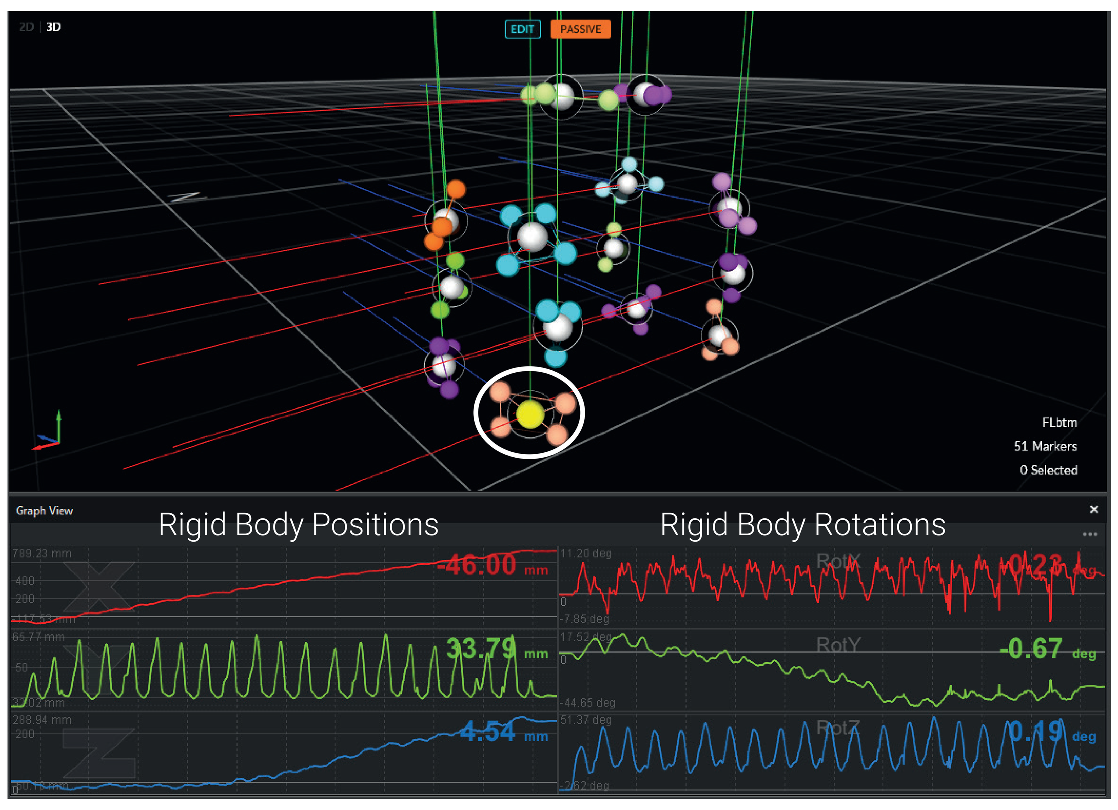


Motion Capture System

- Setup consists of six OptiTrack Prime 41 high-precision infrared cameras (Mean tracking error: 0.12 mm).



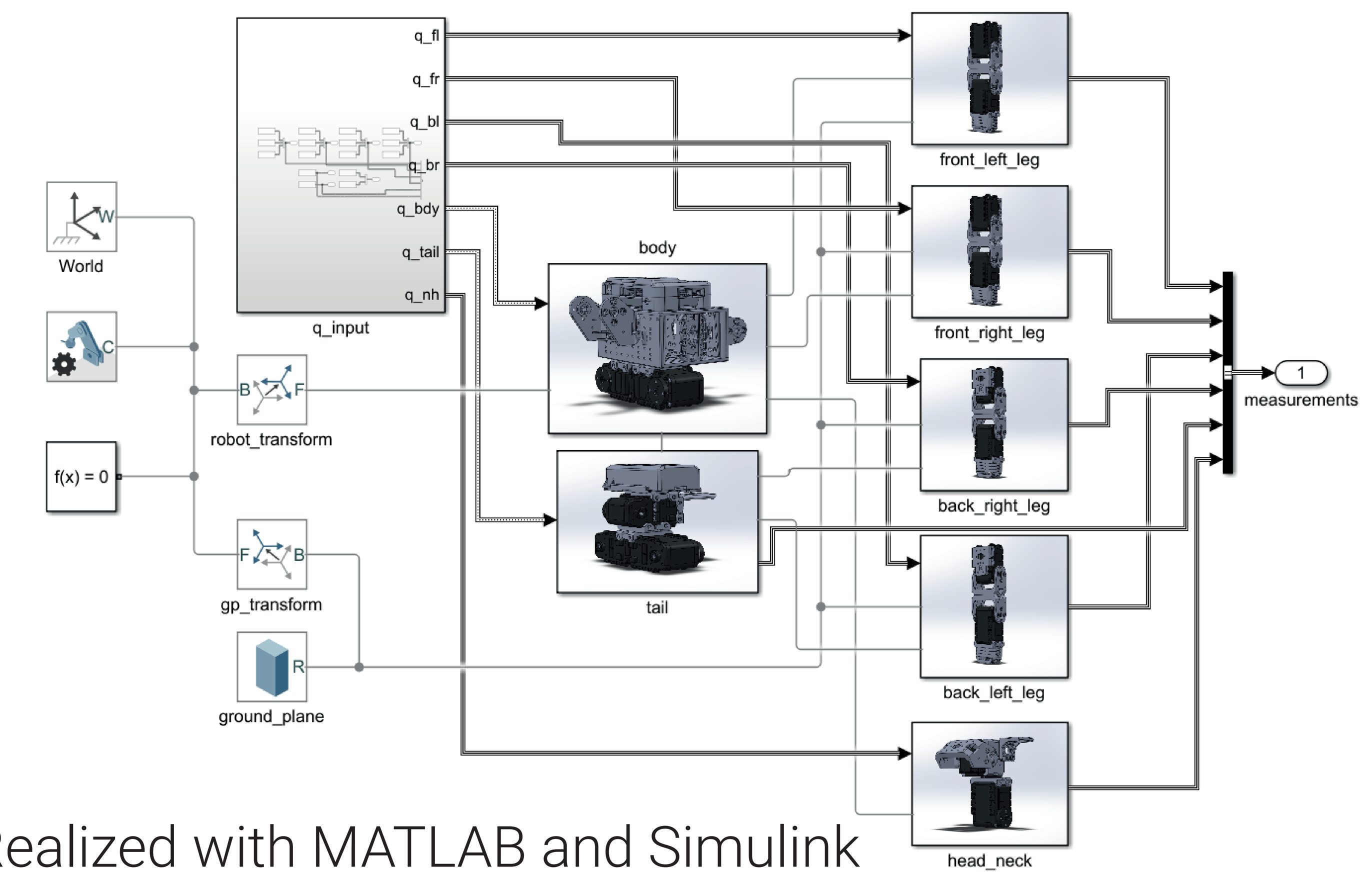
- 6-DOF tracking (position and rotation) of rigid bodies using reflective markers
- 3-4 refelctive markers define a rigid body of the robot.
- Tracking the robot’s body, tail, and legs



Export 6-DOF data to simulation

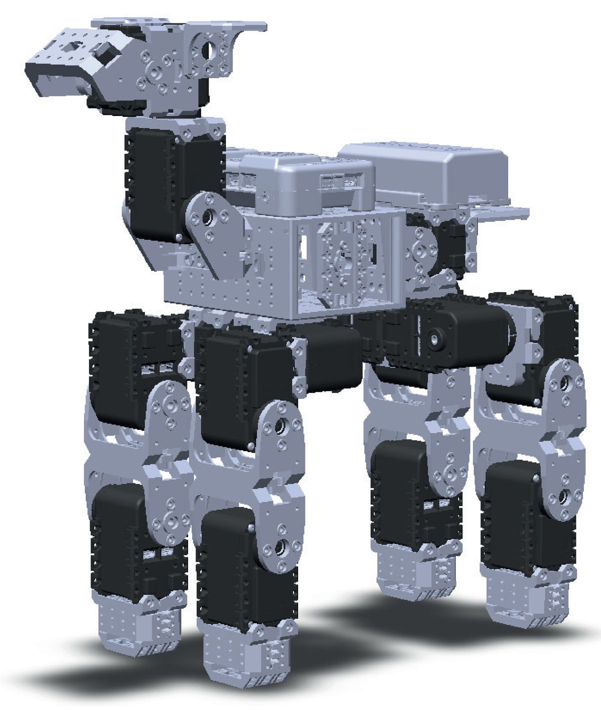
Export simulation results to robot

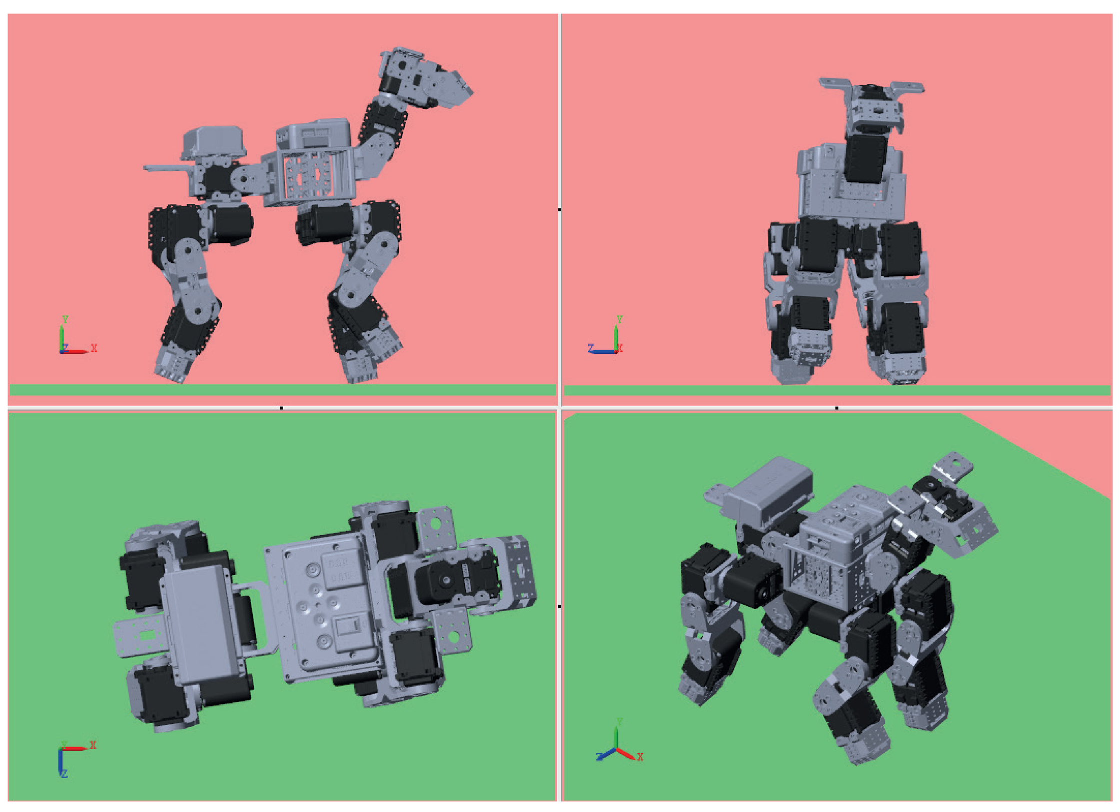
Simulation



- Realized with MATLAB and Simulink
- Blocks represent robot geometry or physical properties.
- Lines represent signal flow.
- Computation of inverse dynamics
- Input: joint angles, velocities, acceleration (q_input), Output: position of robot’s body, torque, contact forces (measurements)

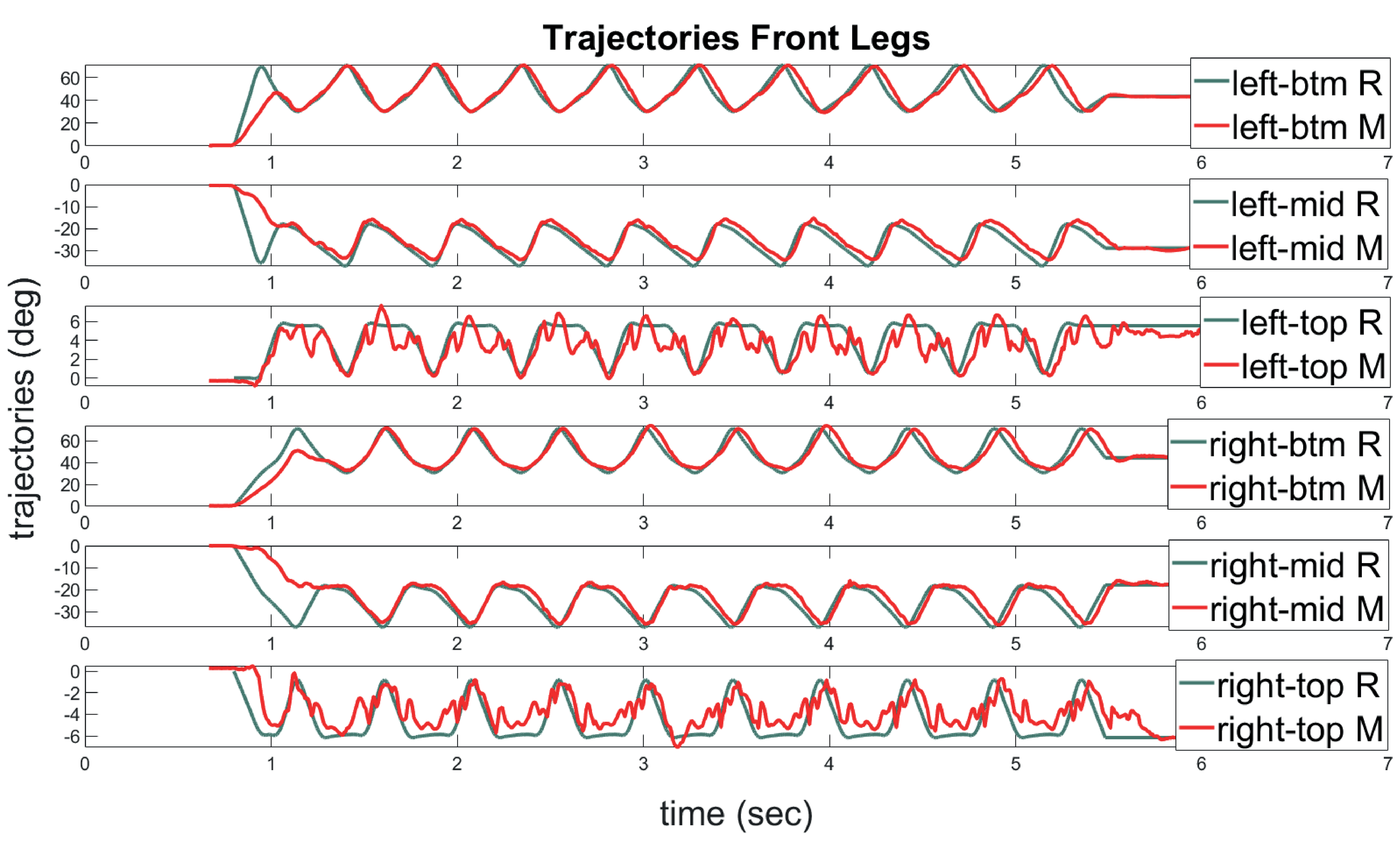
Virtual robot model

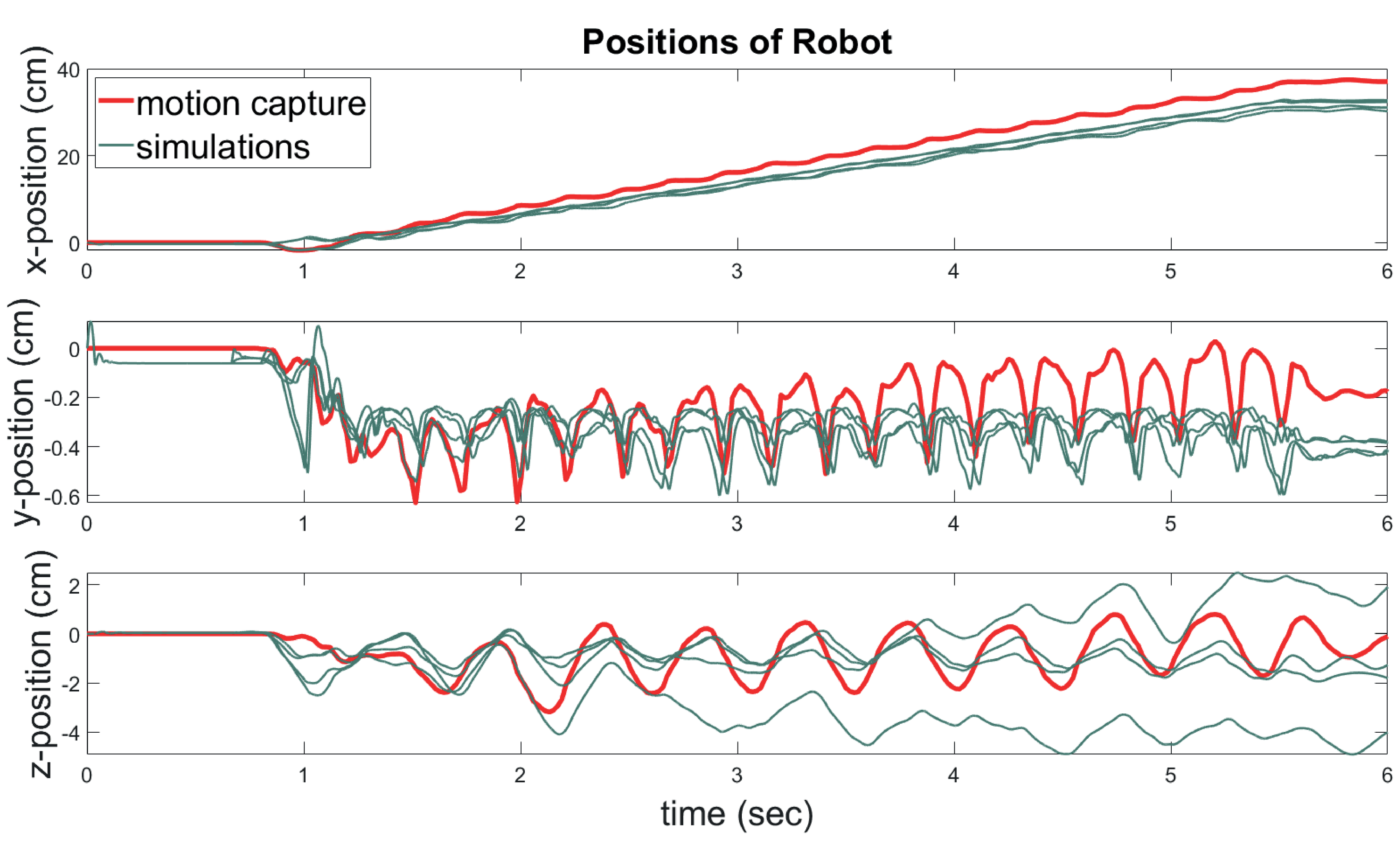




Comparison: Real-World and Simulated Data

- Motion capture trajectories (M) are noisier than ideal trajectories (R).
- Simulated robot walks in average 4.45 cm less far than real robot.





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