Learn2improve

section report

Goal

Facilitate the running energy efficiency optimization/adaption process by providing additional sensor feedback, i.e. motor tracking error and motor current/torque.

Scenario:

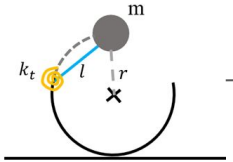
Based on the sensor feedback and the learned physics, the robot know how to adjust its running gait to improve the energy efficiency most effectively when it runs on different terrain or using different leg.

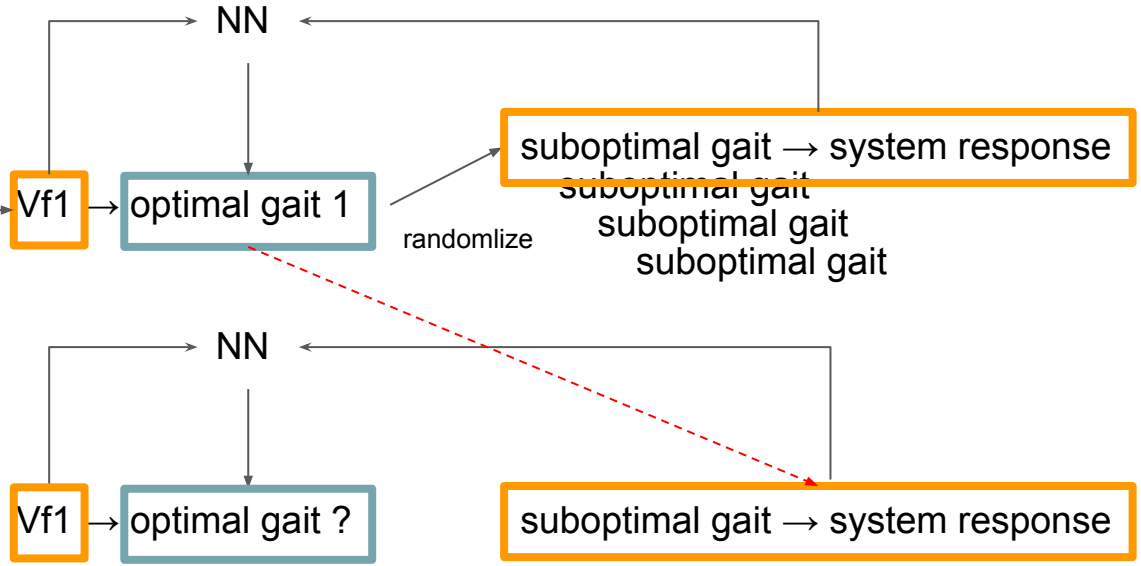
Current Method

RHex → R-SLIP model

Since the optimal running gait exists for R-SLIP, we know the most effective way to improve the efficiency, i.e. adjust the current gait to fit the optimal gait. By perturbing the optimal gait, numerous suboptimal gait can be generated. The system response of R-SLIP running using these suboptimal gaits can be simulated using MATLAB. We train a neural network to learn the relation between “current gait, system response, a user command” and “the most effective way to adjust the current gait.” We assume this relation of RHex and R-SLIP is the similar such that this trained NN can improve the efficiency of RHex.

Current Method





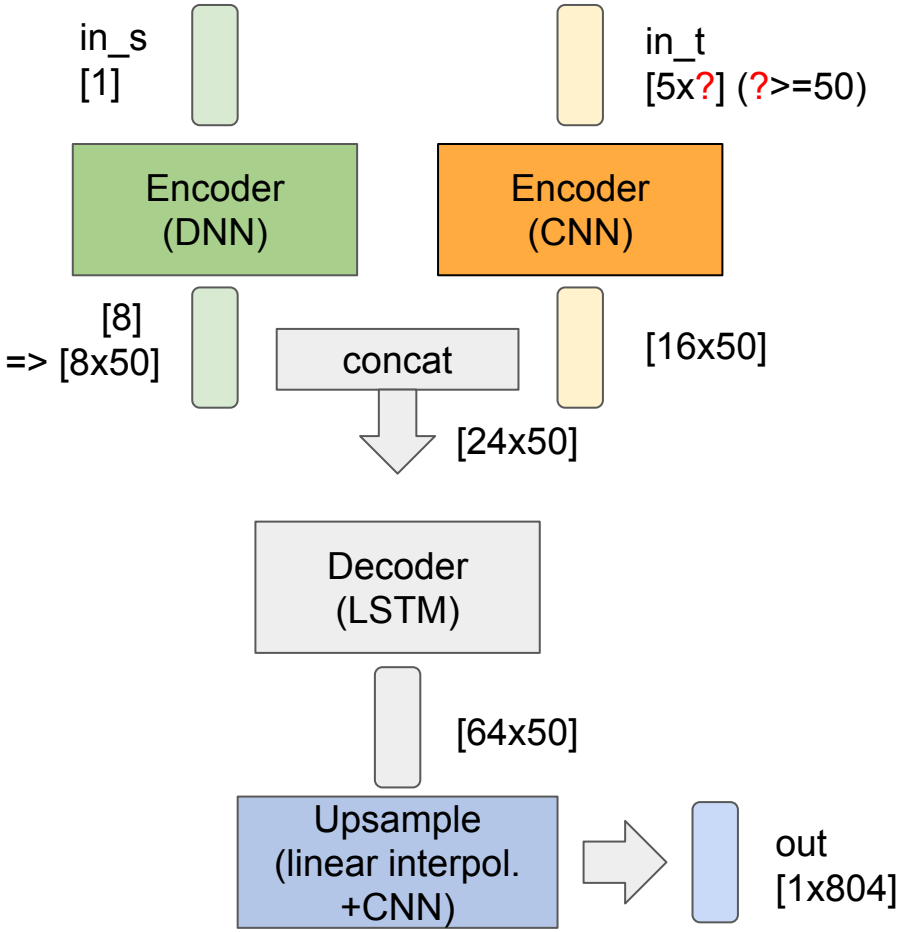
Model architecture

I/O type: traj.

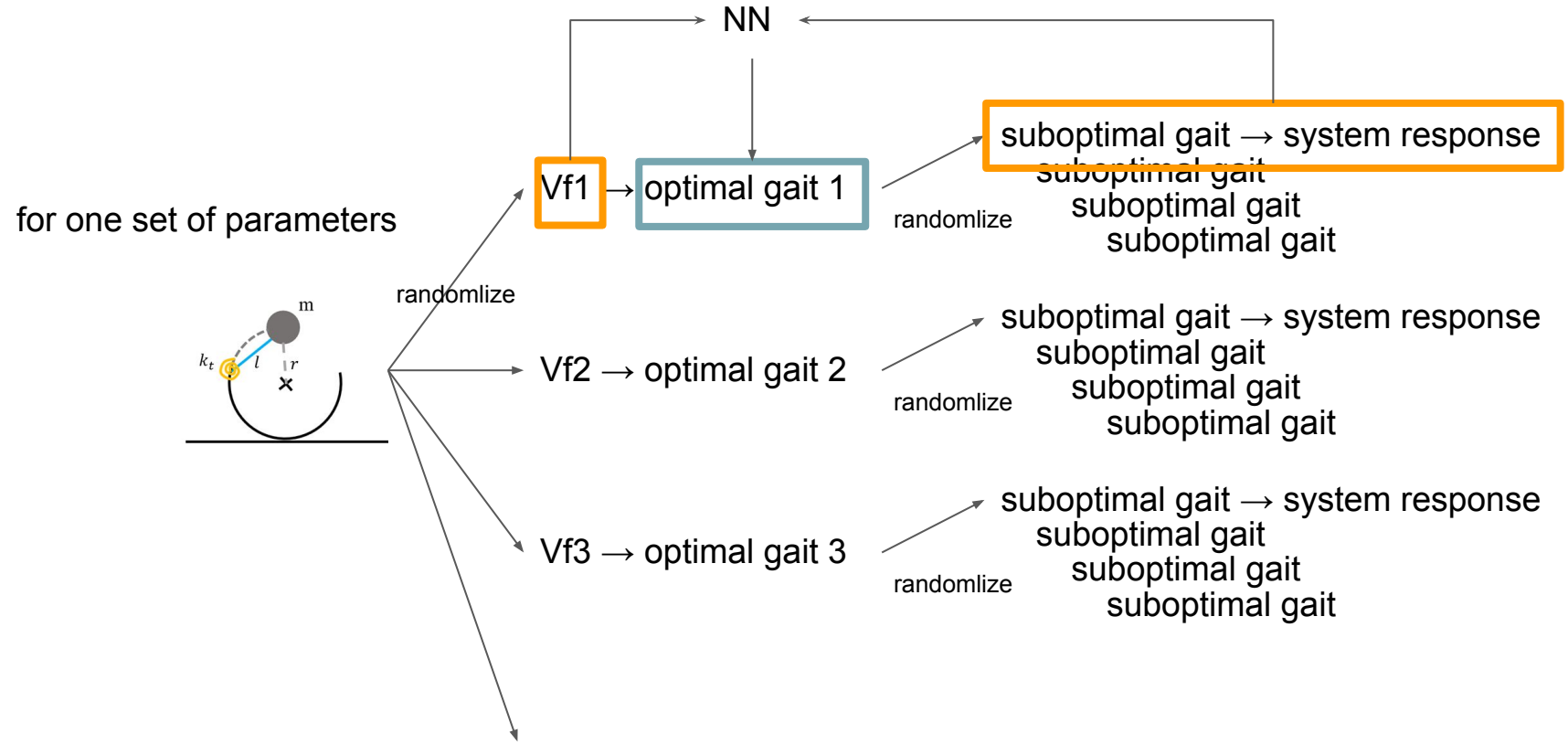
in_s[1]:
[Vf]

in_t [5x?]:
[traj_cmd, torque
tracking_error]

out [1x804]:
[delta_traj]

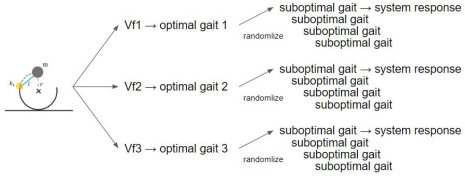


Why this might works?

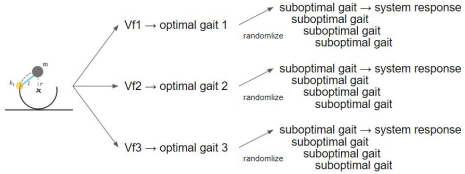


Why this might works?

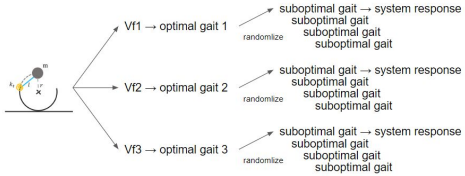
kt = 30



kt = 25

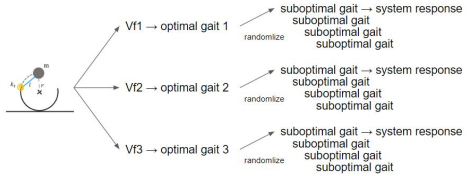


kt = 20

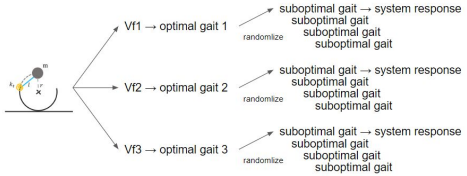


m = 1

m = m_robot
kt = kt_robot
…



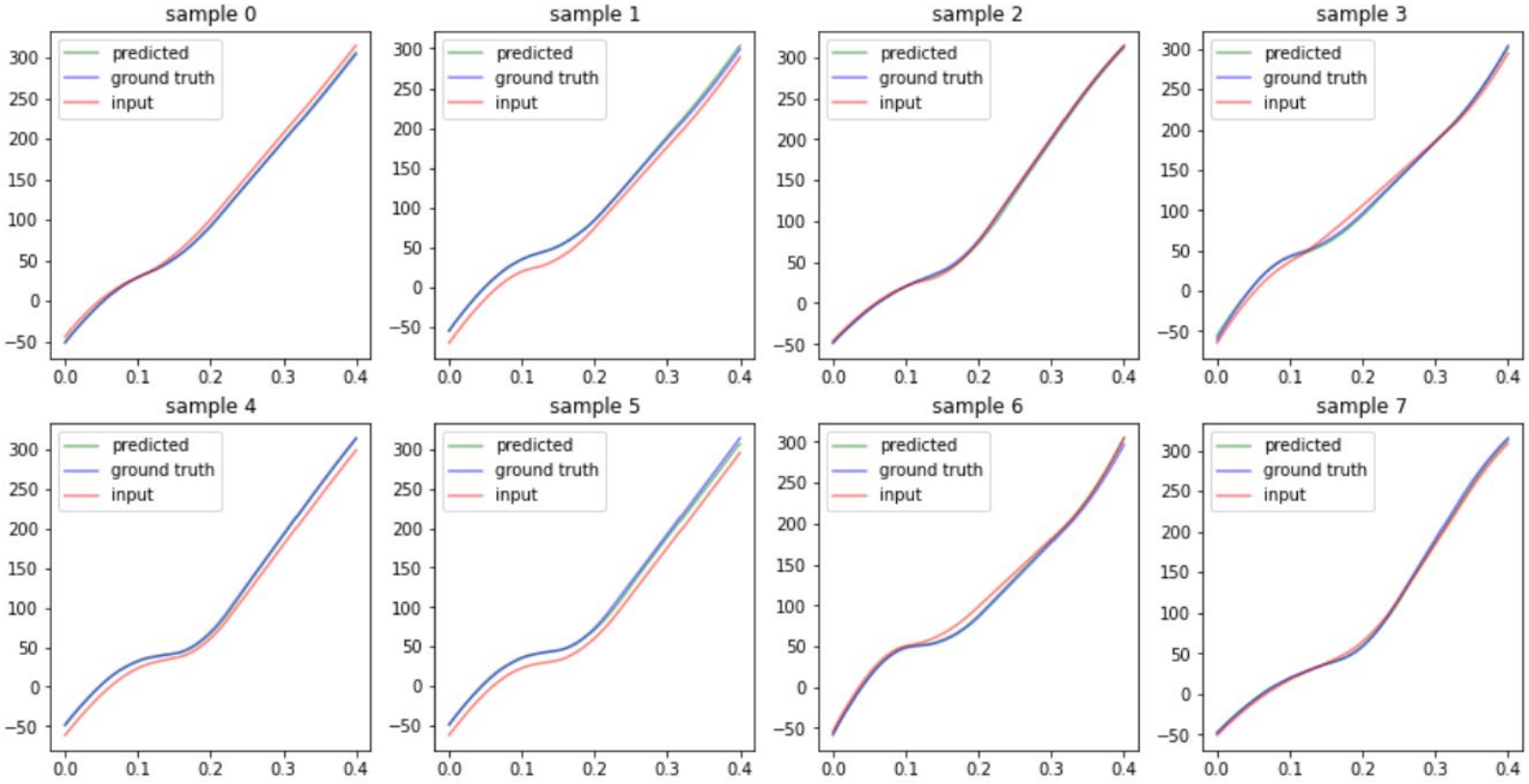
m = 2



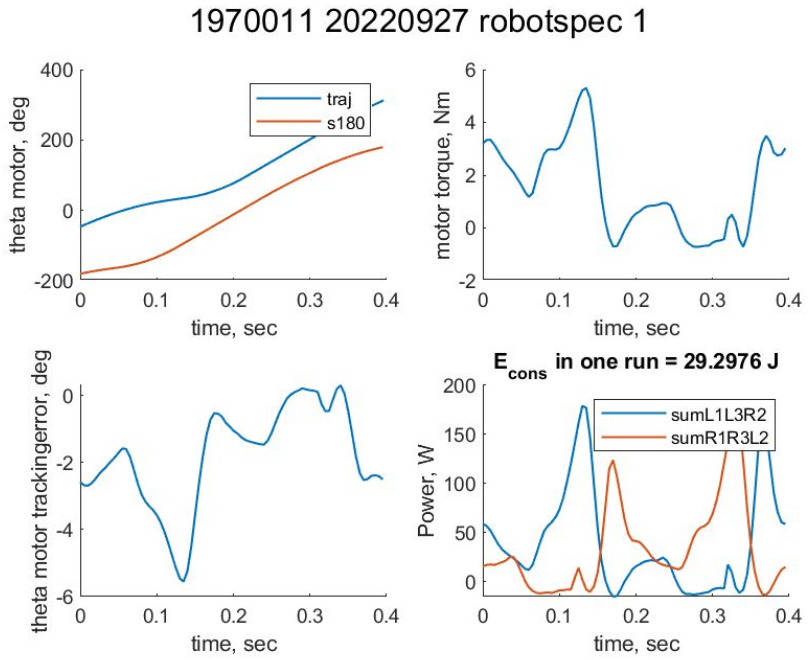
m = 3

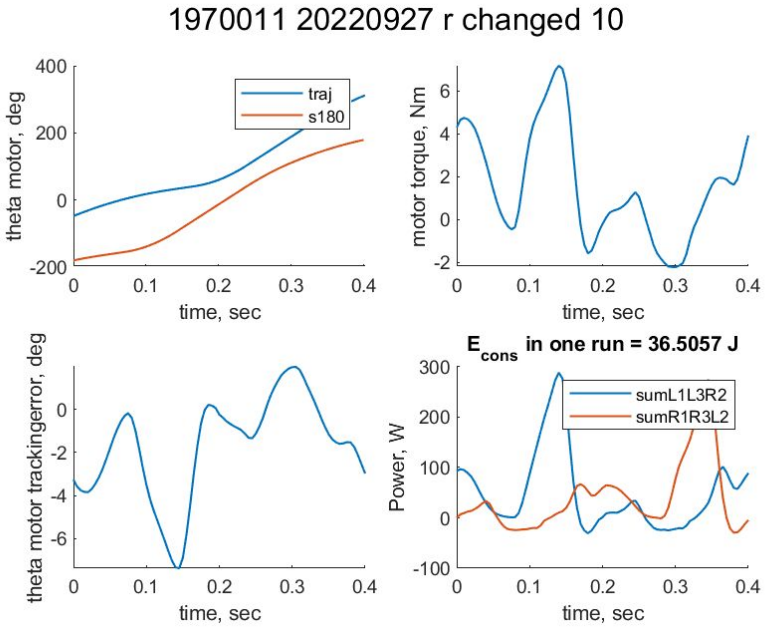
We assume the behavior of the real-world robot is within the distribution of R-SLIP model with perturbed parameters.

Current result - NN training

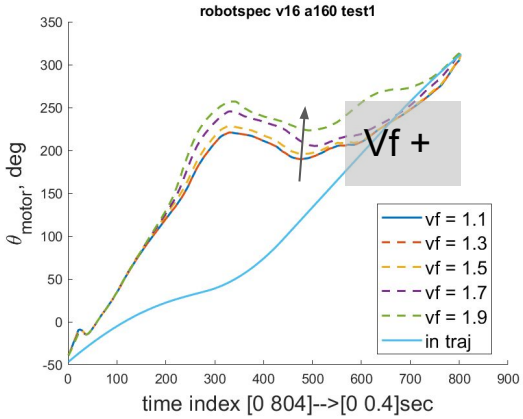


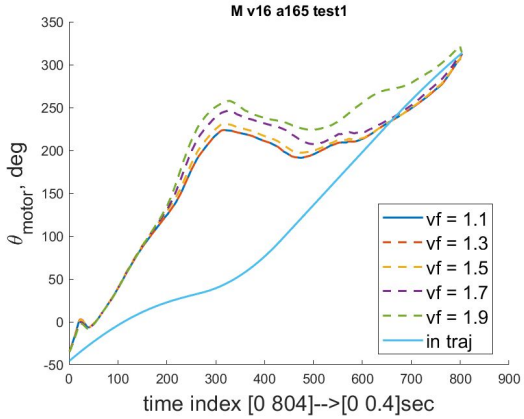
Experiment validation

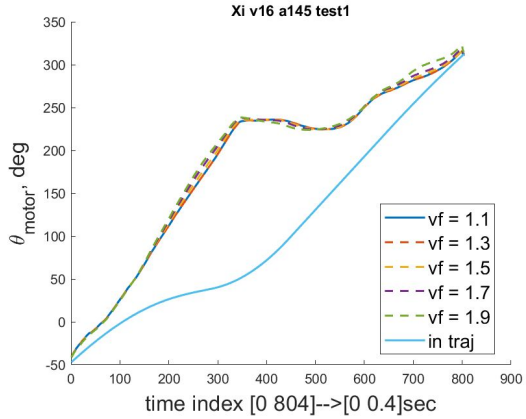


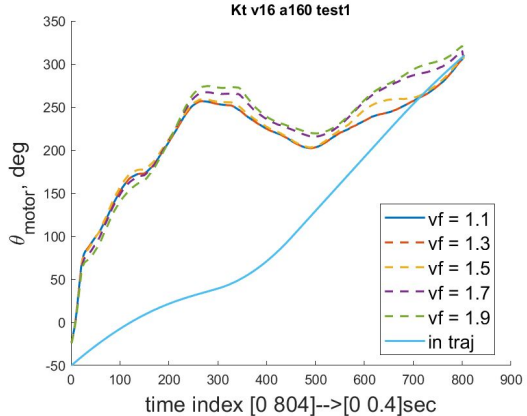


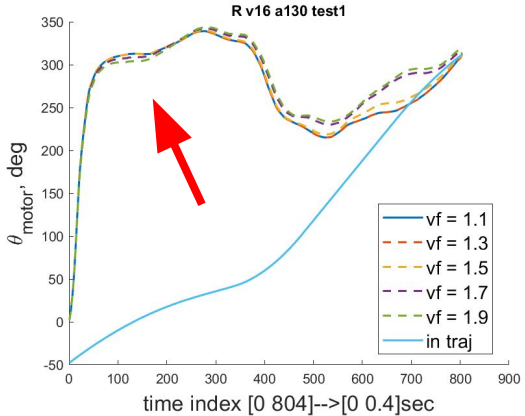
Current result - Experiment validation

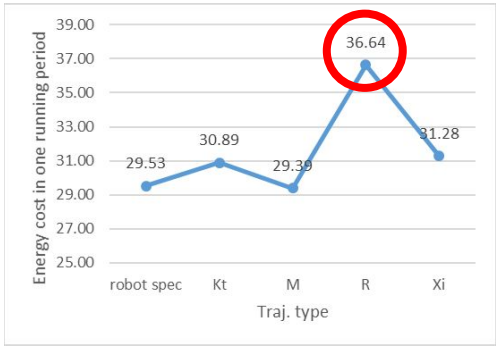












Summary and possible direction

The preliminary experimental result is not satisfying. This might be caused by

1. Disparency between RHex and R-SLIP
2. Not feasible randomization method.
   Does the range of perturbed R-SLIP enclose the behavior of RHex?

Possible solution:

1. Use R-SLIP+GP to replace R-SLIP to reduce the discrepancy between sim and real.
2. Refine the randomization method
3. …