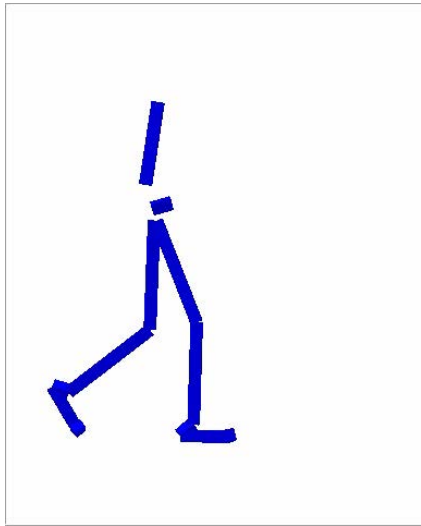


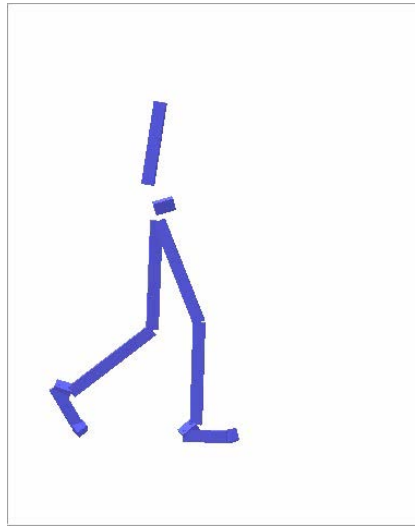
Progress Report

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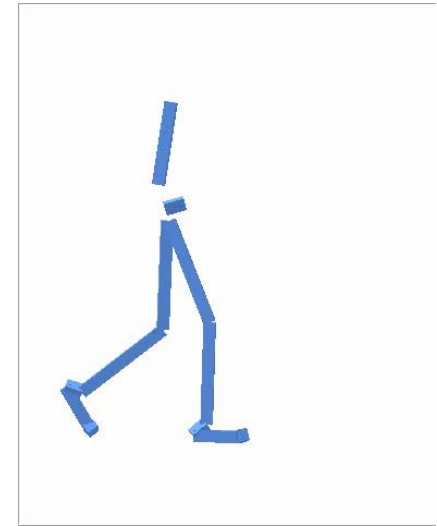
Reference Motions for Various Offsets



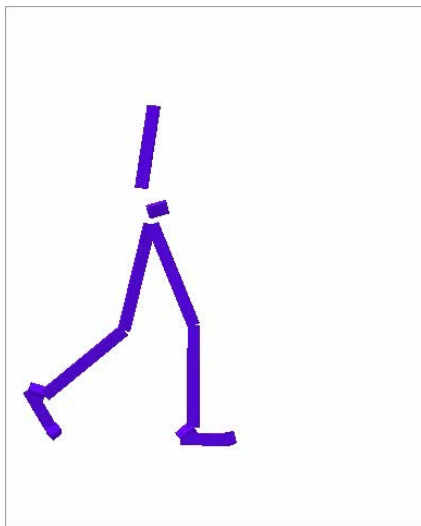
original motion



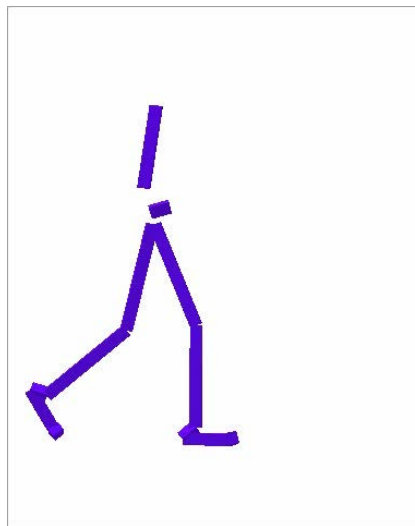
end offset -0.2



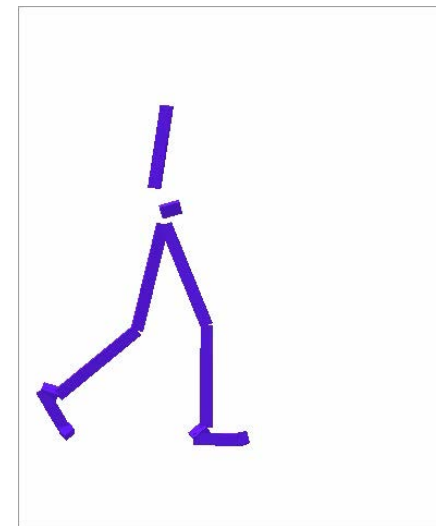
end offset 0.1



start offset -0.1



20% faster

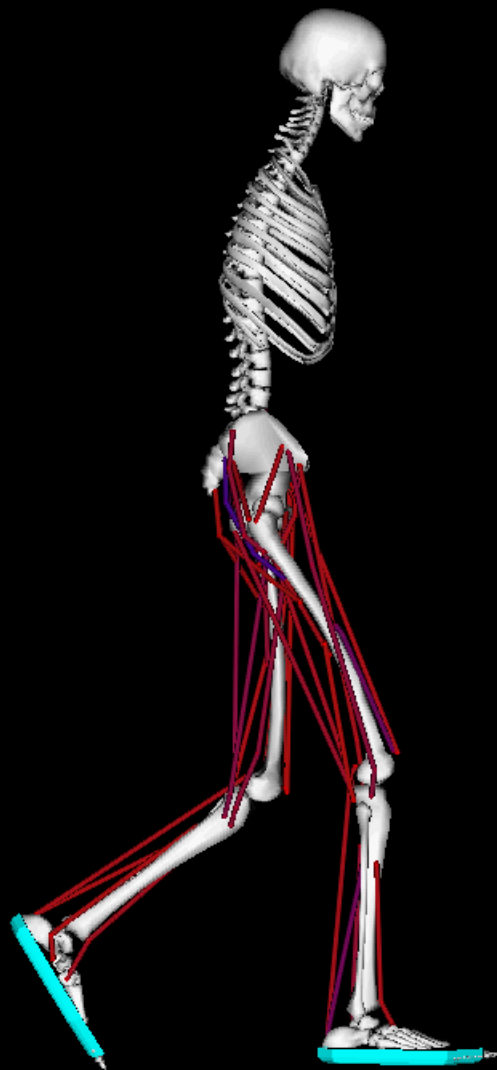


20% slower

Reference Motions

- Single stance : $3*3*3 = 27$
- Double stance : $3*3*3 = 27$
- First, optimization for original motion

Computation time
: 2.1 hours



Difficulties

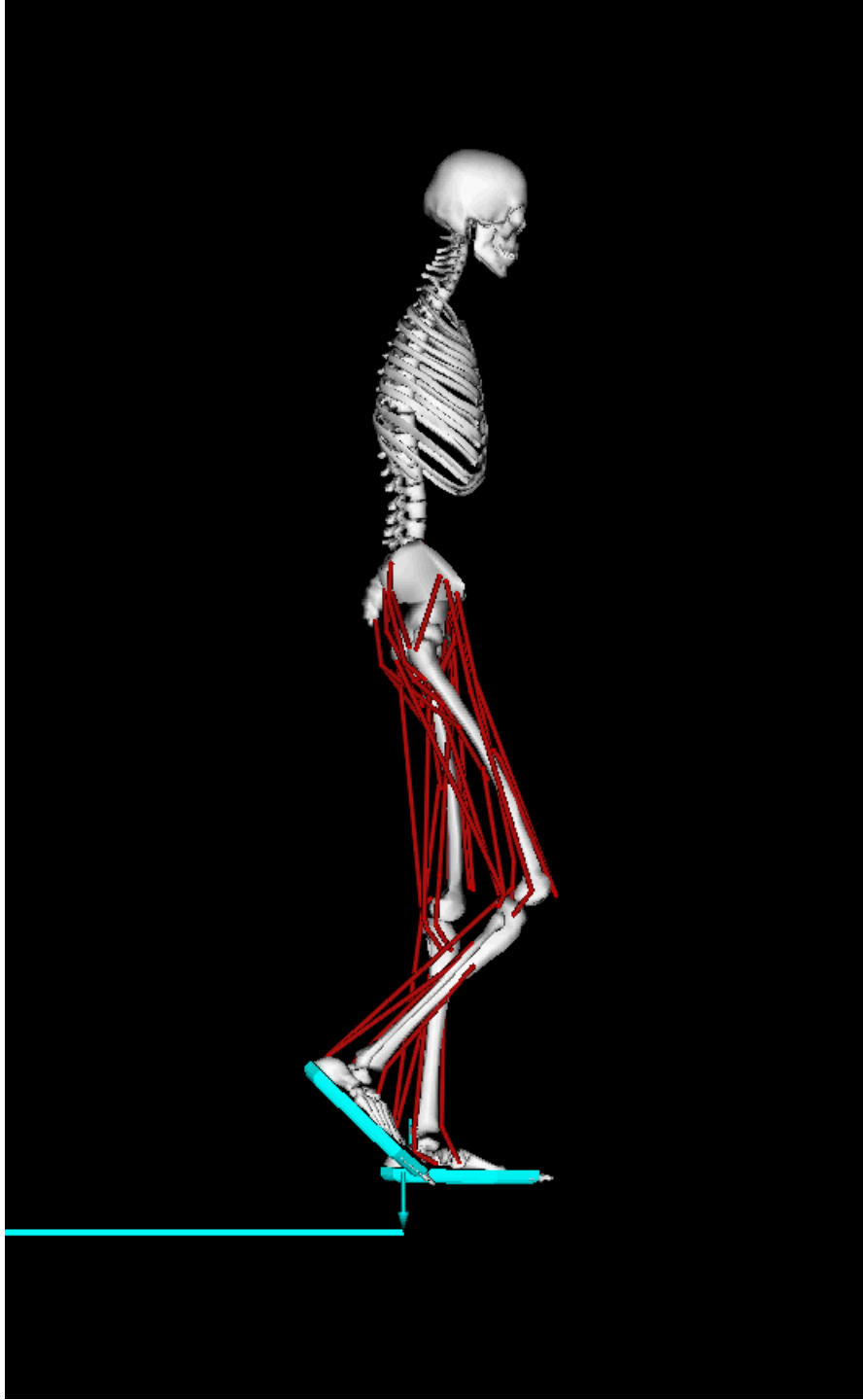
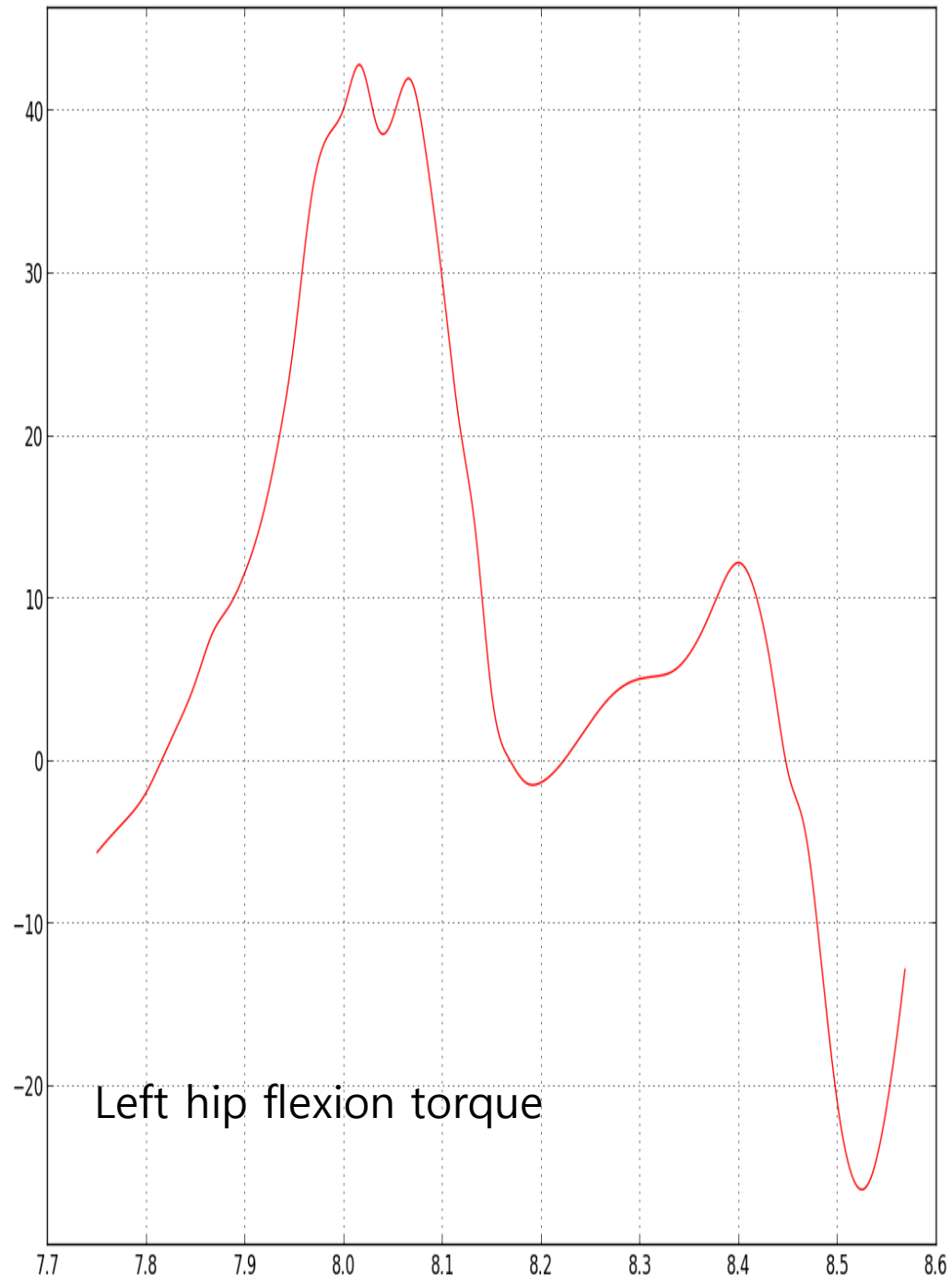
- Slow evaluation (OpenSim rigidbody & muscle dynamics)
- High dimensional problem (240 dims)
- Not solved in reasonable time

Limitation

- Perturbation at unexpected time
 - If control is required like : $0s \sim 0.2s$ - end offset 0.1, $0.2s \sim$ - end offset 0.2
- We need control trajectory from arbitrary start time

Next Approach

- Optimal excitation trajectory for every case is not essential
 - Delay may be compensated by feedback control
- Actuate each muscle instantly (at current joint configuration)
- Use reference torque for normal walk



Thank you