Modeling & Control of a Longboard-Riding Robot

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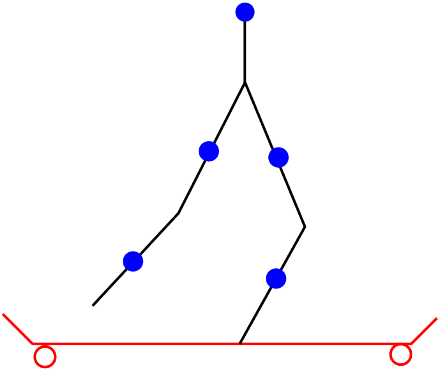
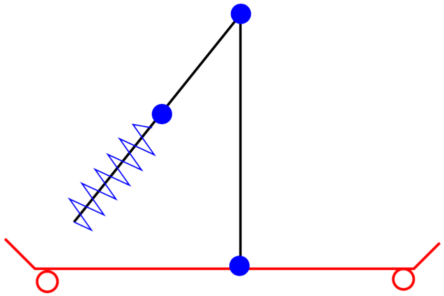
6.832 Final Project
Spring 2012

Inspiration

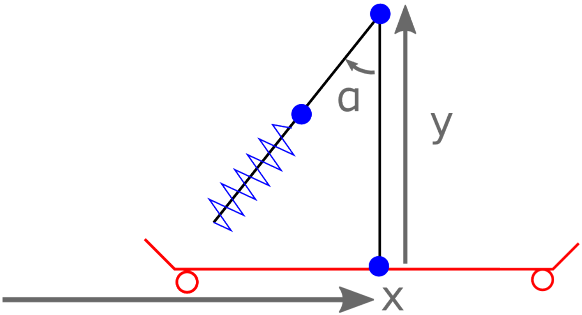
System Model



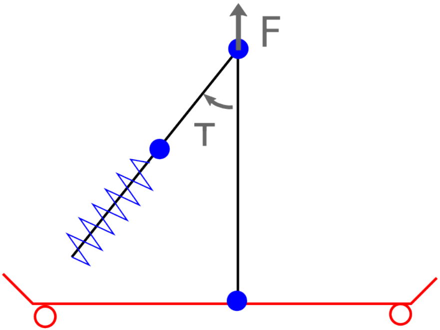
Simplified Model



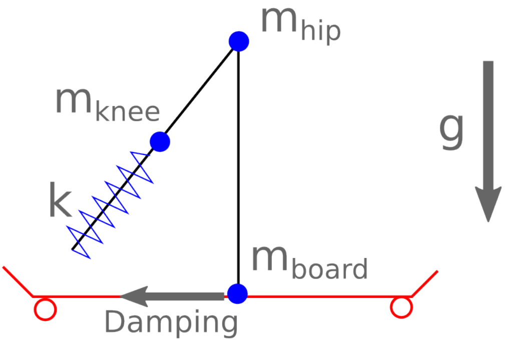
State Variables



Control Inputs



System Parameters



System Summary

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- $\mathbf{u} = [F, \tau]'$
- Gliding and pushing modes
  - $y_{\text{toe}} \leq 0 \rightarrow$ pushing
  - $y_{\text{toe}} > 0 \rightarrow$ gliding

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- Exports as MATLAB scripts

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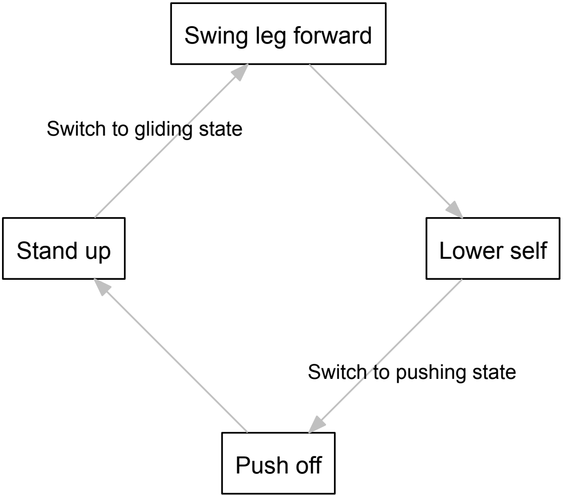
- Double integrator control

Controller Strategy

High-level strategy breaks motion into stages



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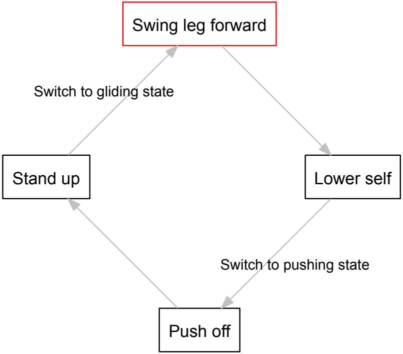

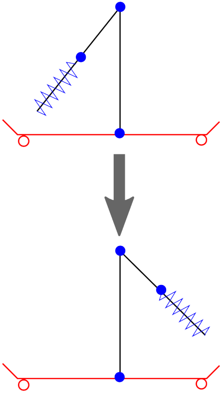

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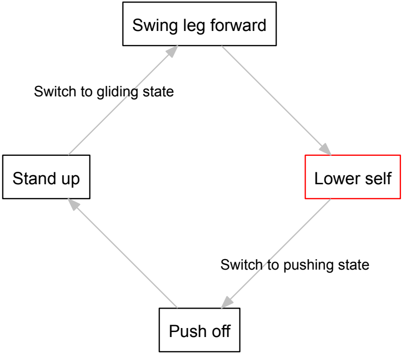

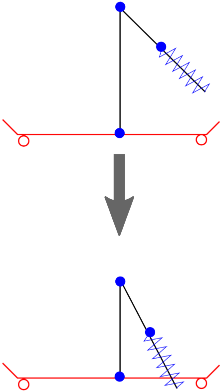

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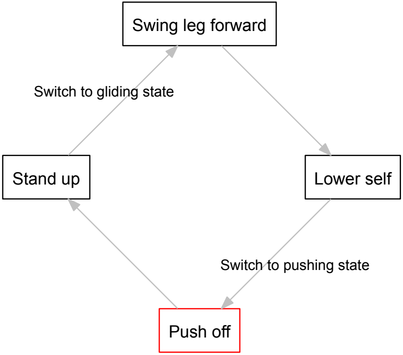

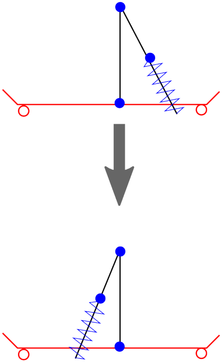

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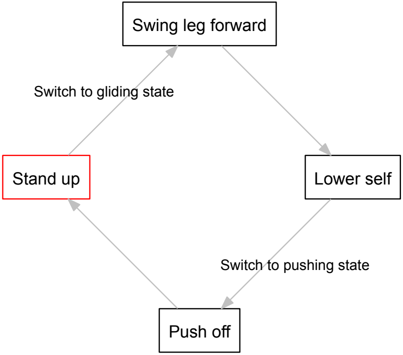

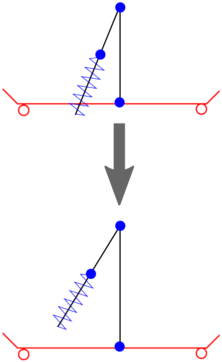

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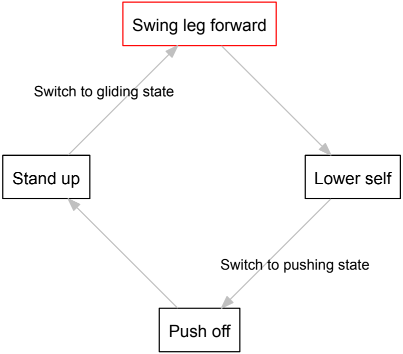

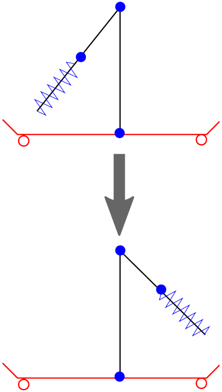

Demo

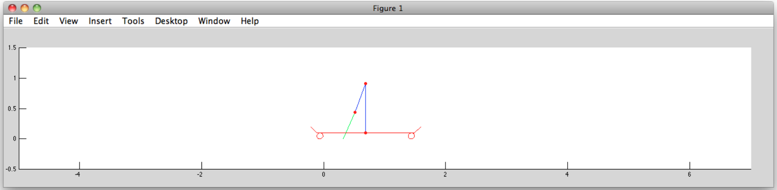

Figure 1
File Edit View Insert Tools Desktop Window Help
1.5
1
0.5
0
-0.5
-4
-2
0
2
4
6

Controller Parameters

Controller is parameterized by three terms:

α_{hit}	Angle of collision
α_{stand}	Angle ending push
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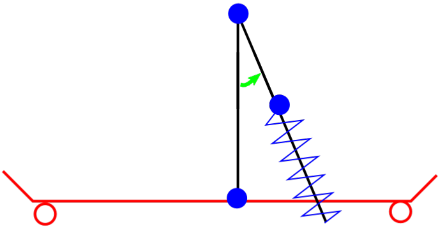

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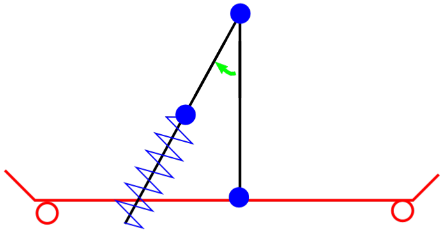

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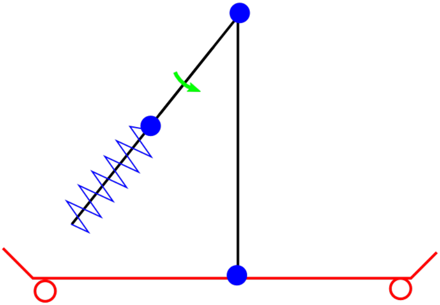

Stochastic Gradient Descent

Optimized for distance travelled in fixed time

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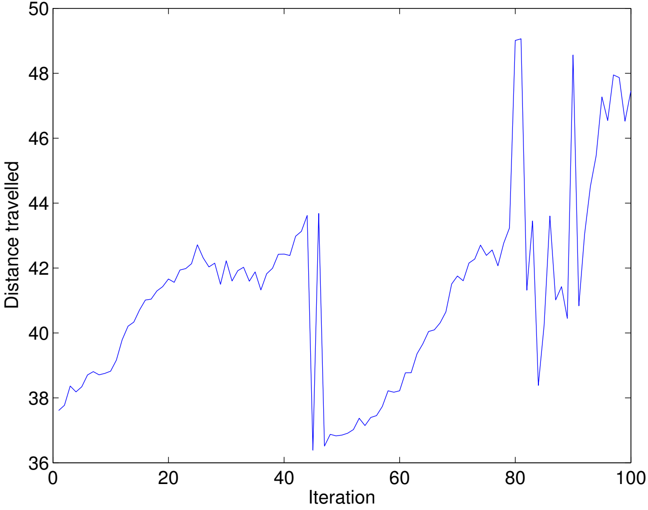
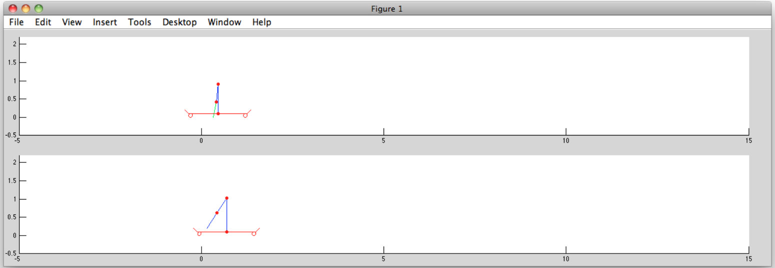


Optimized Demo



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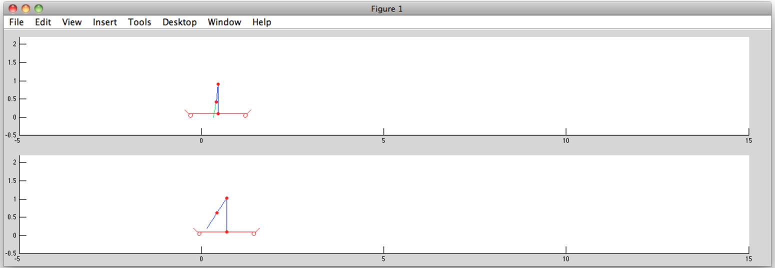

20% improvement!

Summary

- Developed simplified system model
- Wrote dynamics-solving tools
- Designed high-level controller behavior
- Used gradient descent to optimize parameters

Questions?