Control of an Inverted Pendulum

Rick Egeland, Kevin Renna
Advisors: Kurt Wick and Paul Crowell

Outline

- Motivation of project, ideas
- Theory, control method
- Complications
- Success
- Conclusion

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"Neural Network Models: An Analysis"

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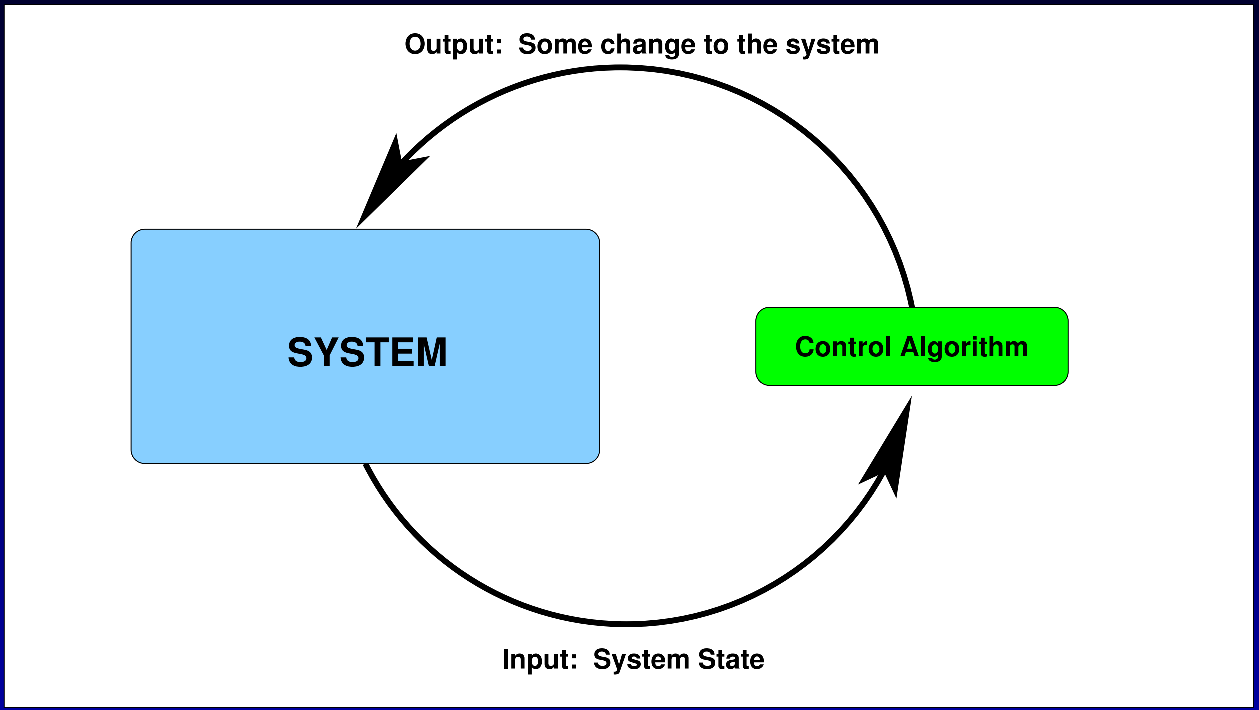
"Neural Network Models: An Analysis"

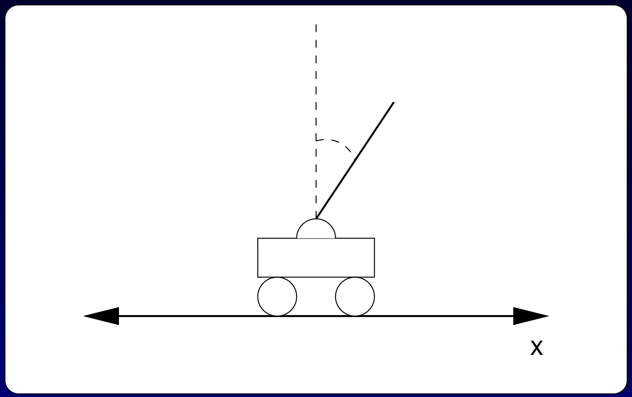
- Need a working apparatus before we can implement a Neural Network
- Proportional integral (PI) Method was used

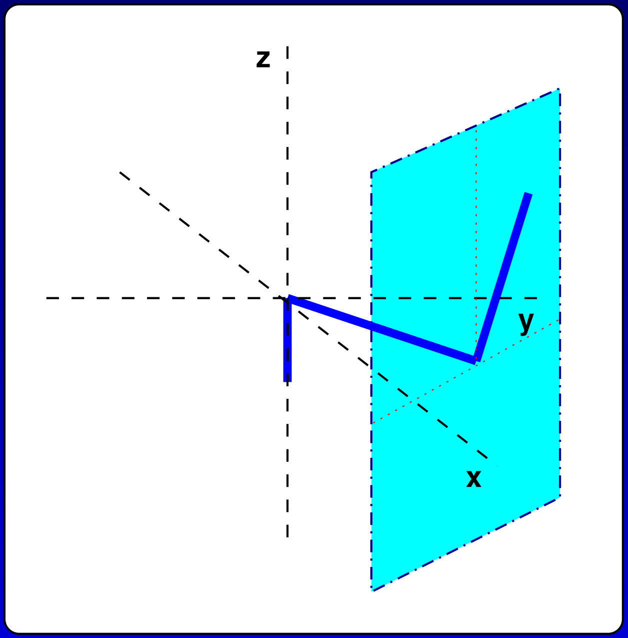
Feedback Systems



- Applications: **Balance**, rockets, industrial uses, chemical reactions

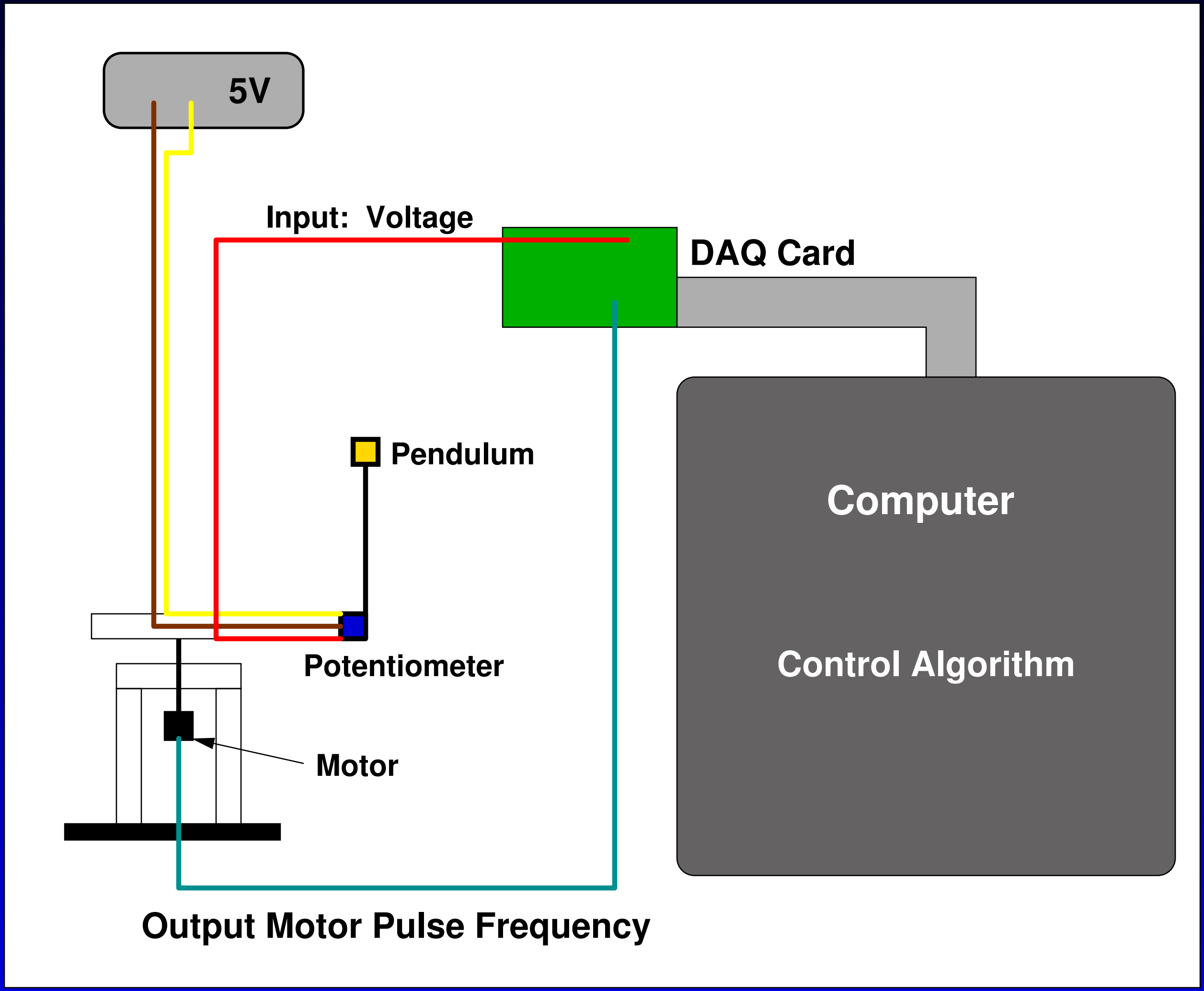
Our Apparatus





- Want a only a 2D problem
- Linear setup vs. rotational setup

Our Apparatus



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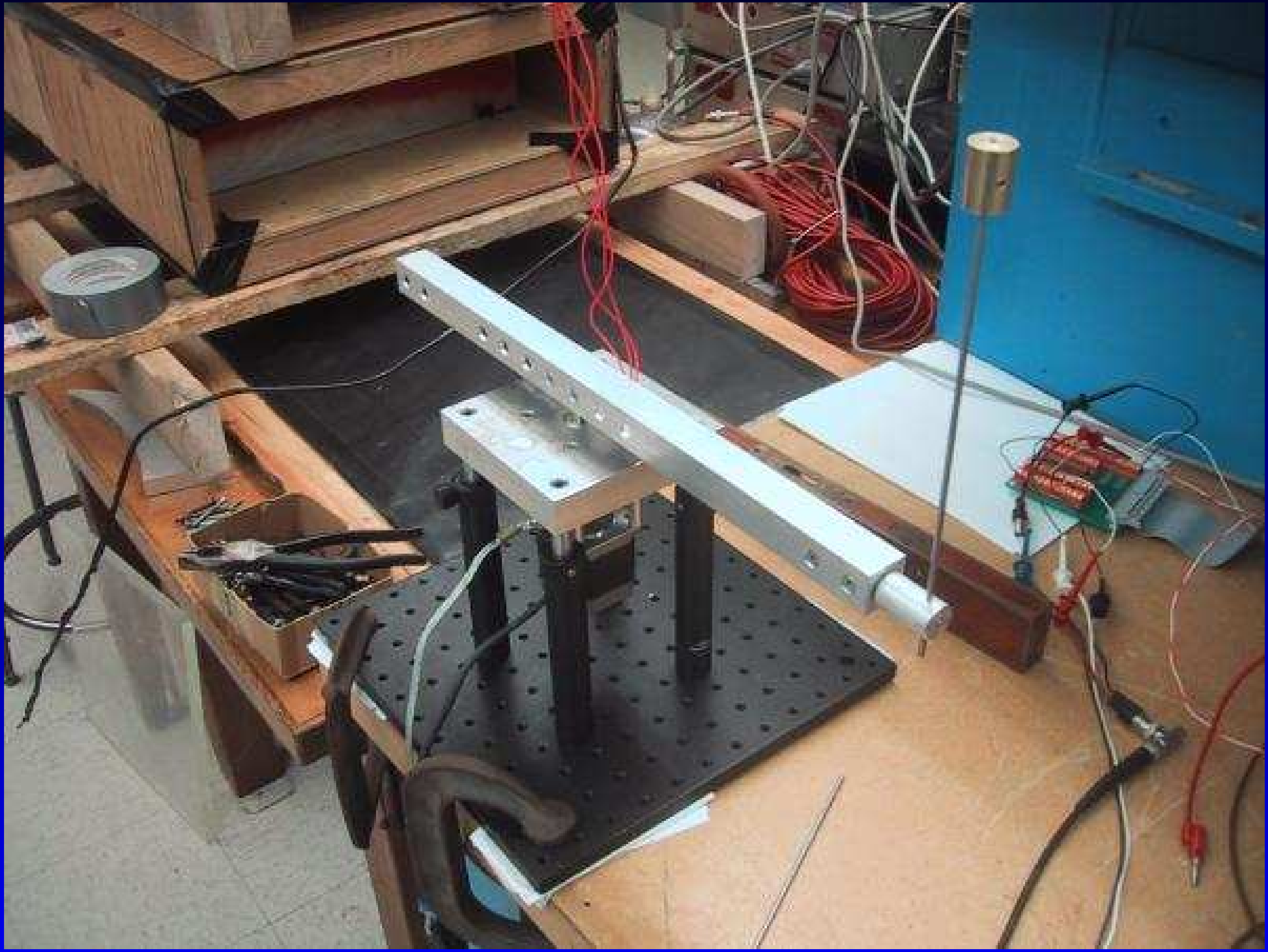
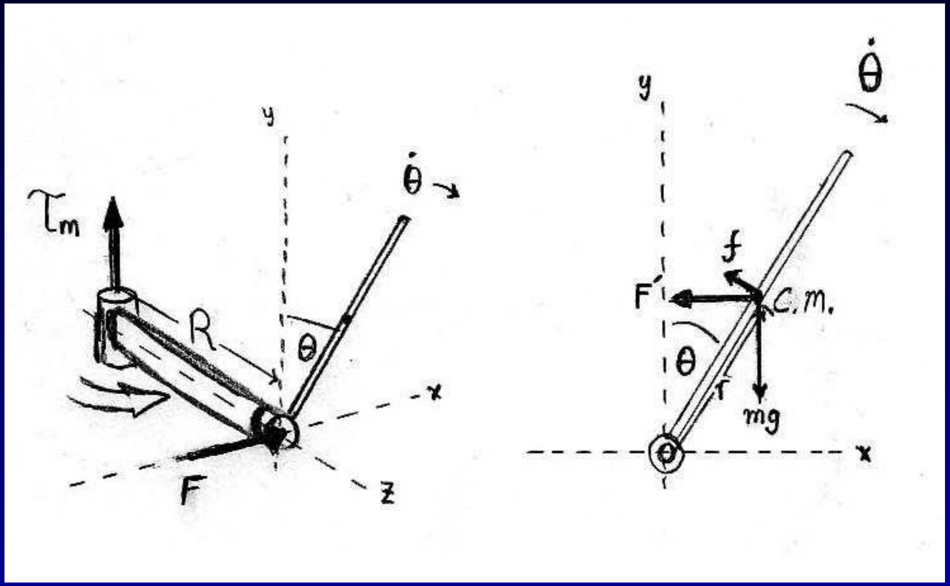


Pendulum Physics



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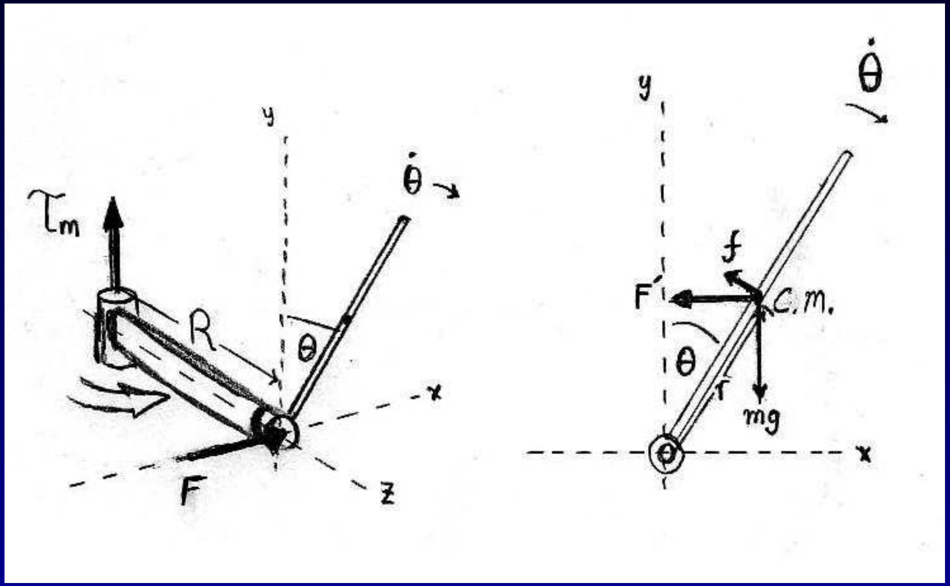
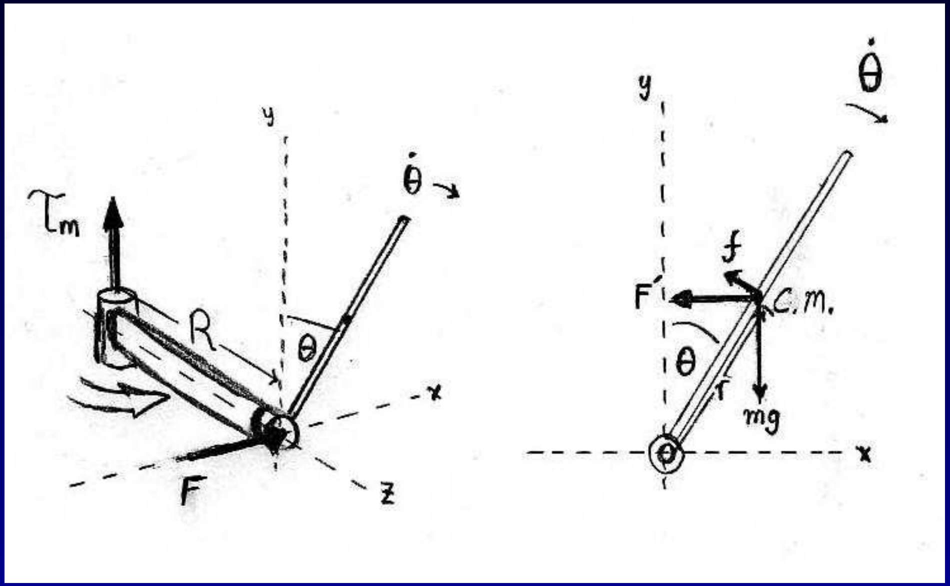


Accelerating base $\rightarrow F$ on c.m. of pendulum

Pendulum Physics



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$$\sum_i \tau_i = I\ddot{\theta}$$

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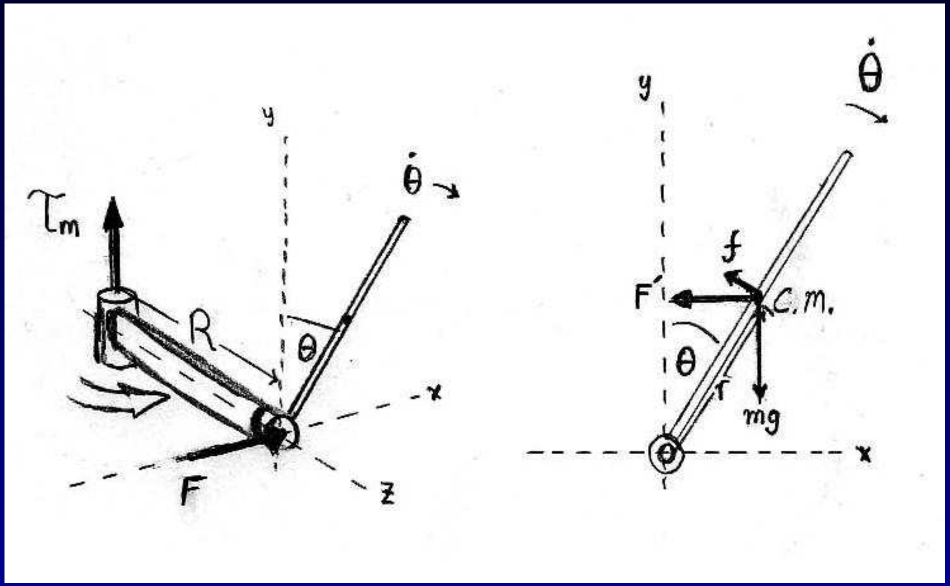

Accelerating base $\rightarrow F$ on c.m. of pendulum

$$\sum_i \tau_i = I\ddot{\theta}$$

$$I\ddot{\theta} = -rmg\sin\theta + \frac{\tau_M r}{R}\cos\theta + b\dot{\theta}$$

Control Method

$$\ddot{\phi} = \frac{\partial \dot{\phi}}{\partial t} \approx \frac{\dot{\phi}_i - \dot{\phi}_{i-1}}{\Delta t}$$

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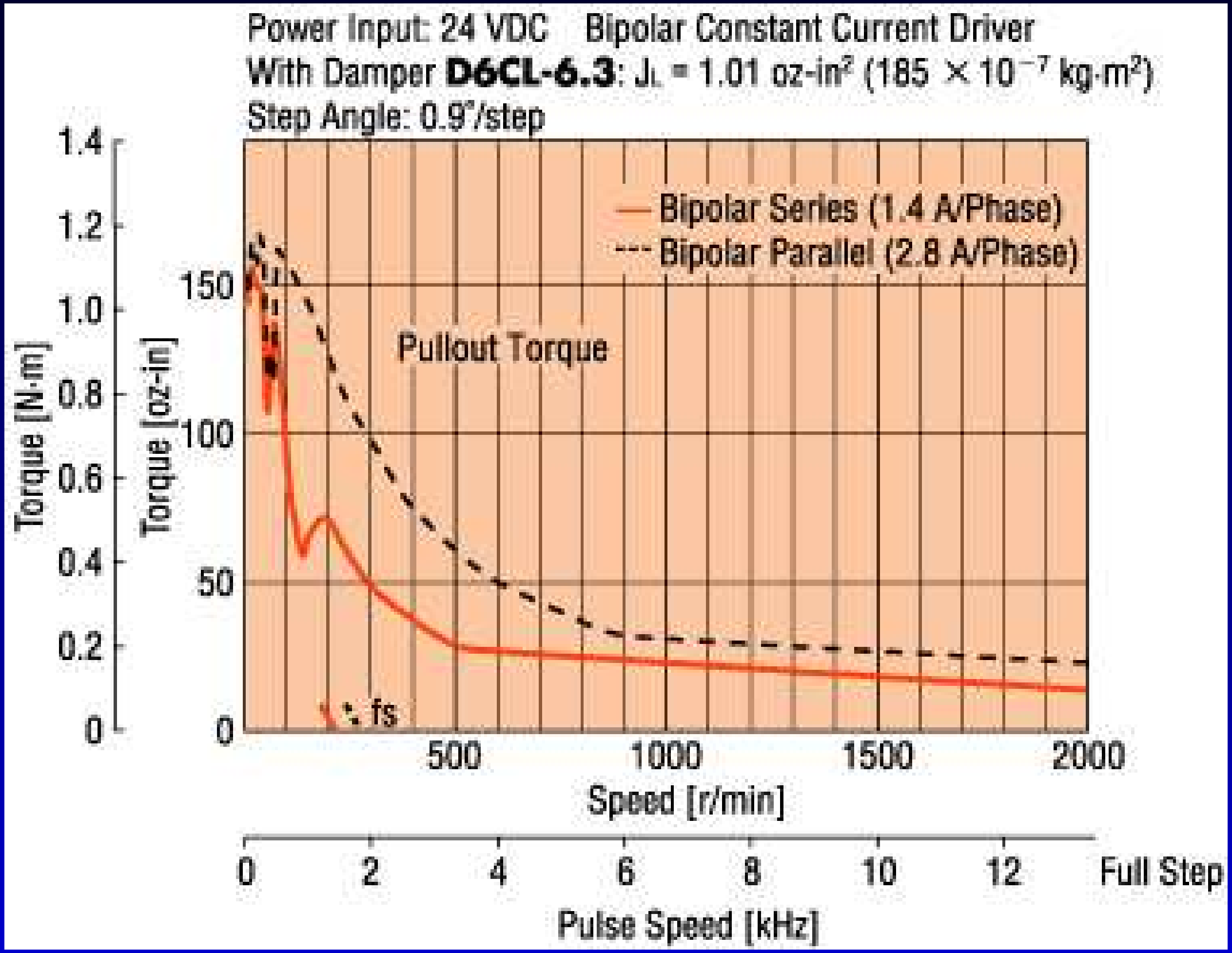
$$\lim_{i \to n, \Delta t \to 0} \dot{\phi}_i = k \int_0^n \theta dt$$

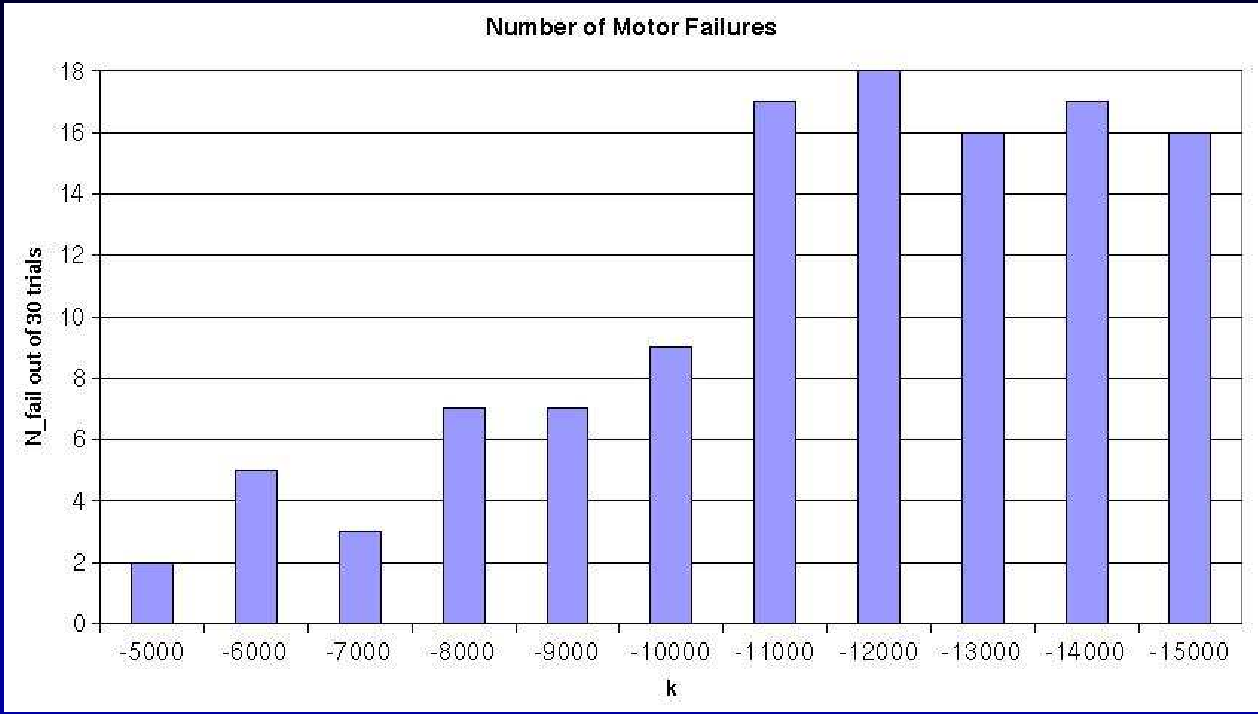
This is why it is called the PI method

Complications



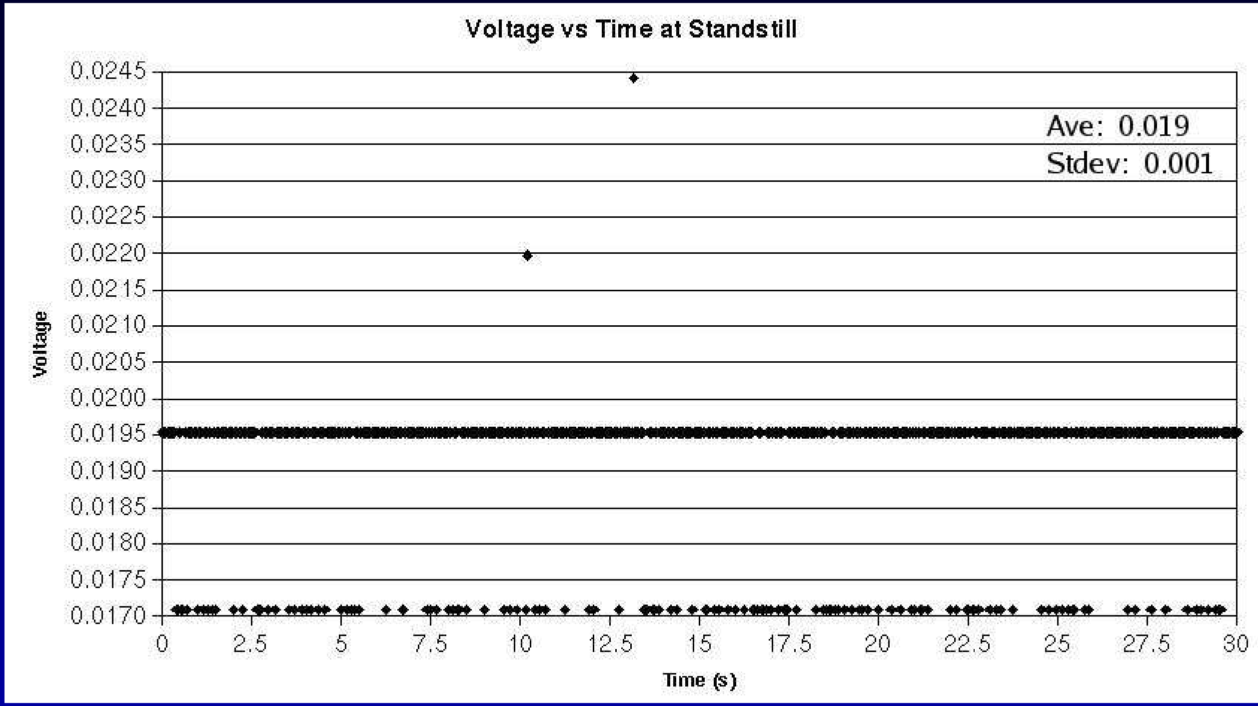
Limited motor torque

Complications



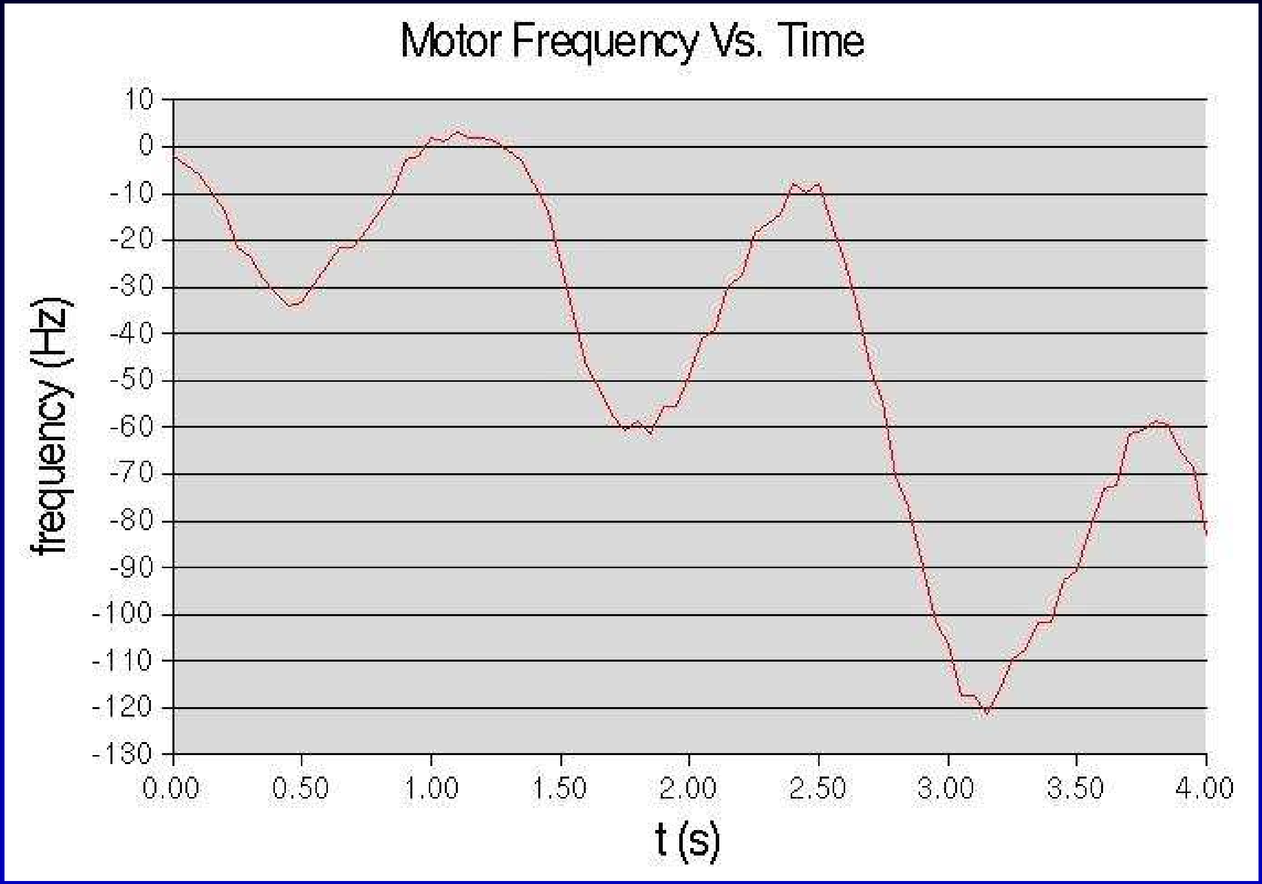
Failures at high torque demand

Complications



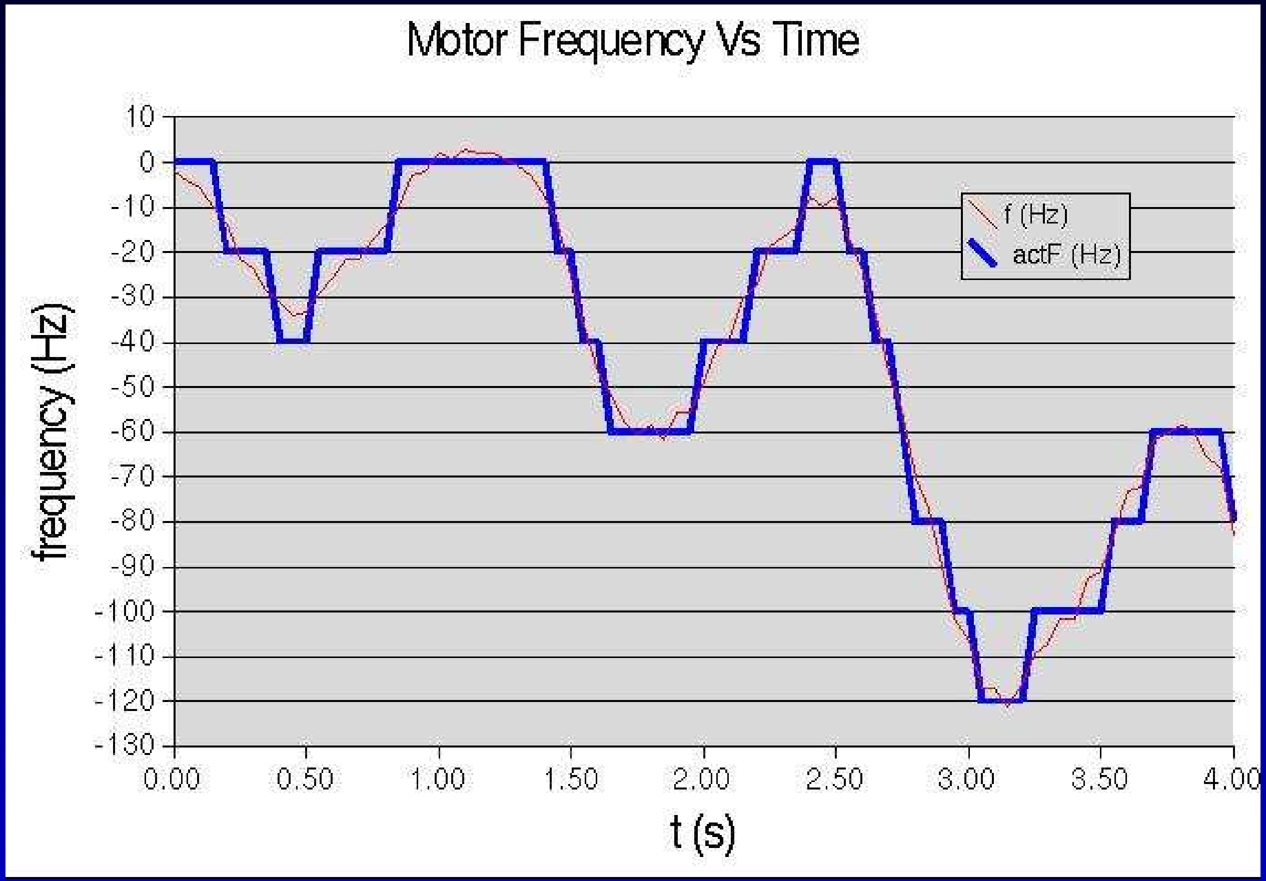
Digital noise

Complications



Quantized motor speeds

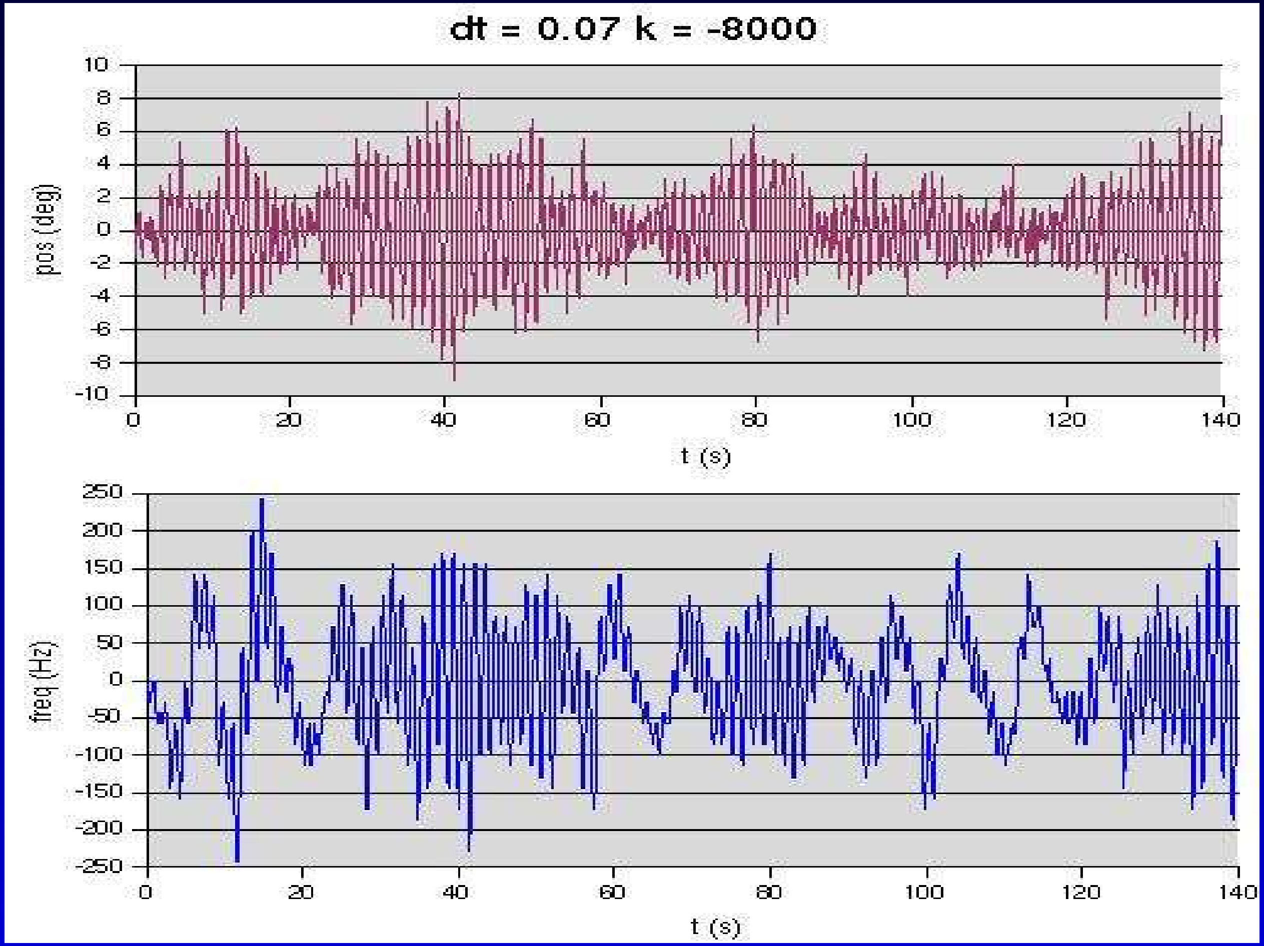
Complications



Quantized motor speeds

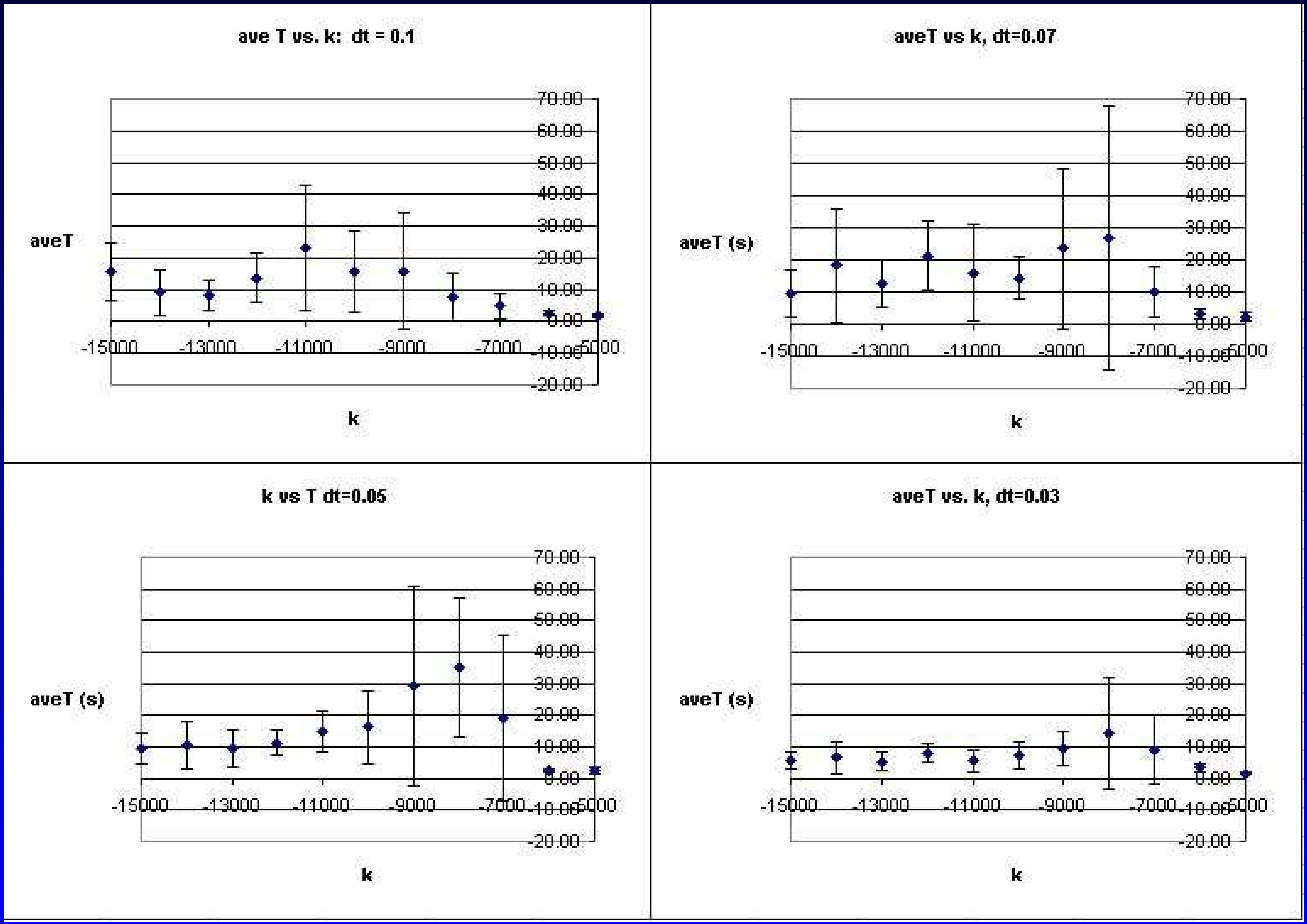
Success

Longest Trial



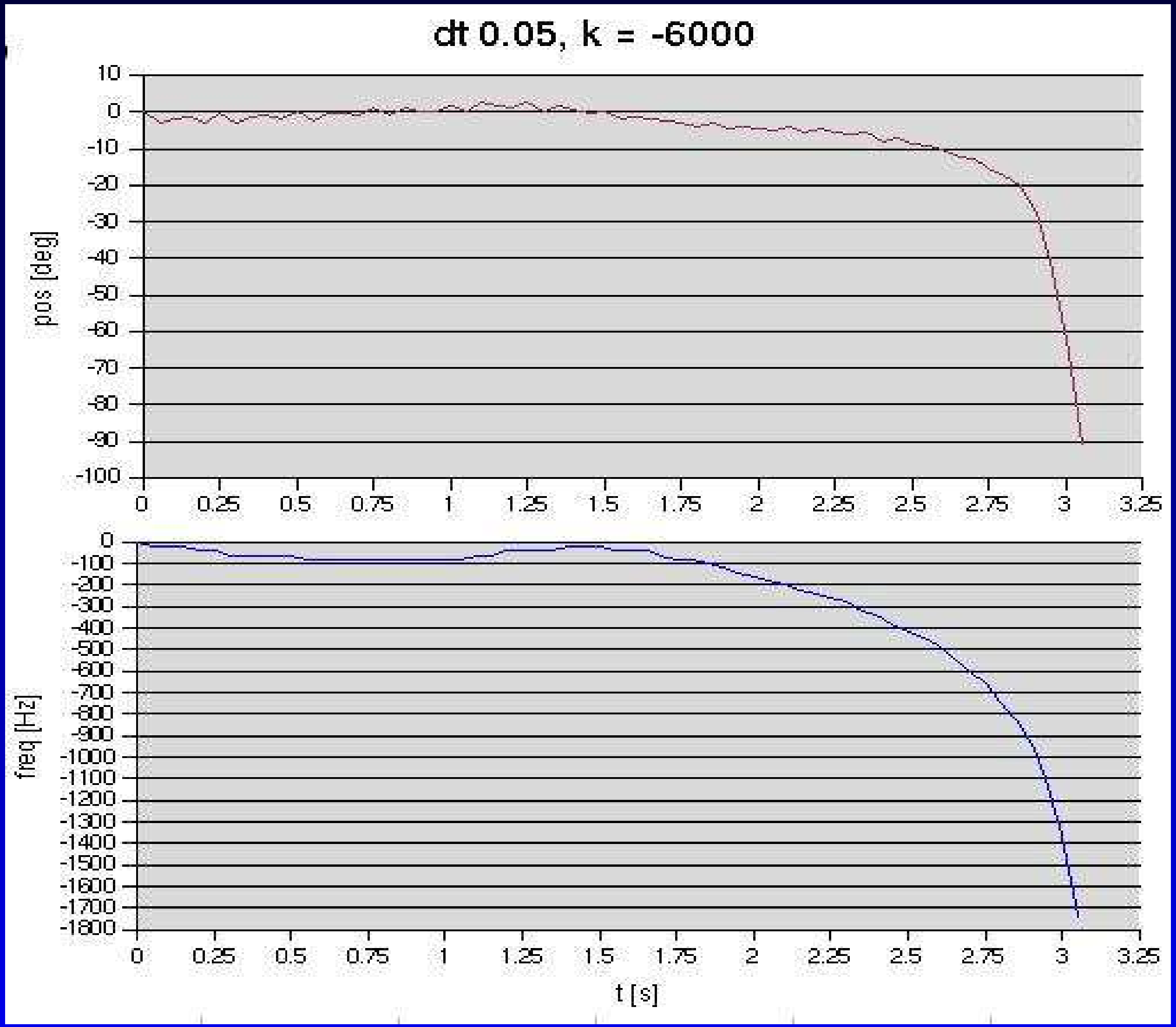
Success

Parameter Data



Behavior

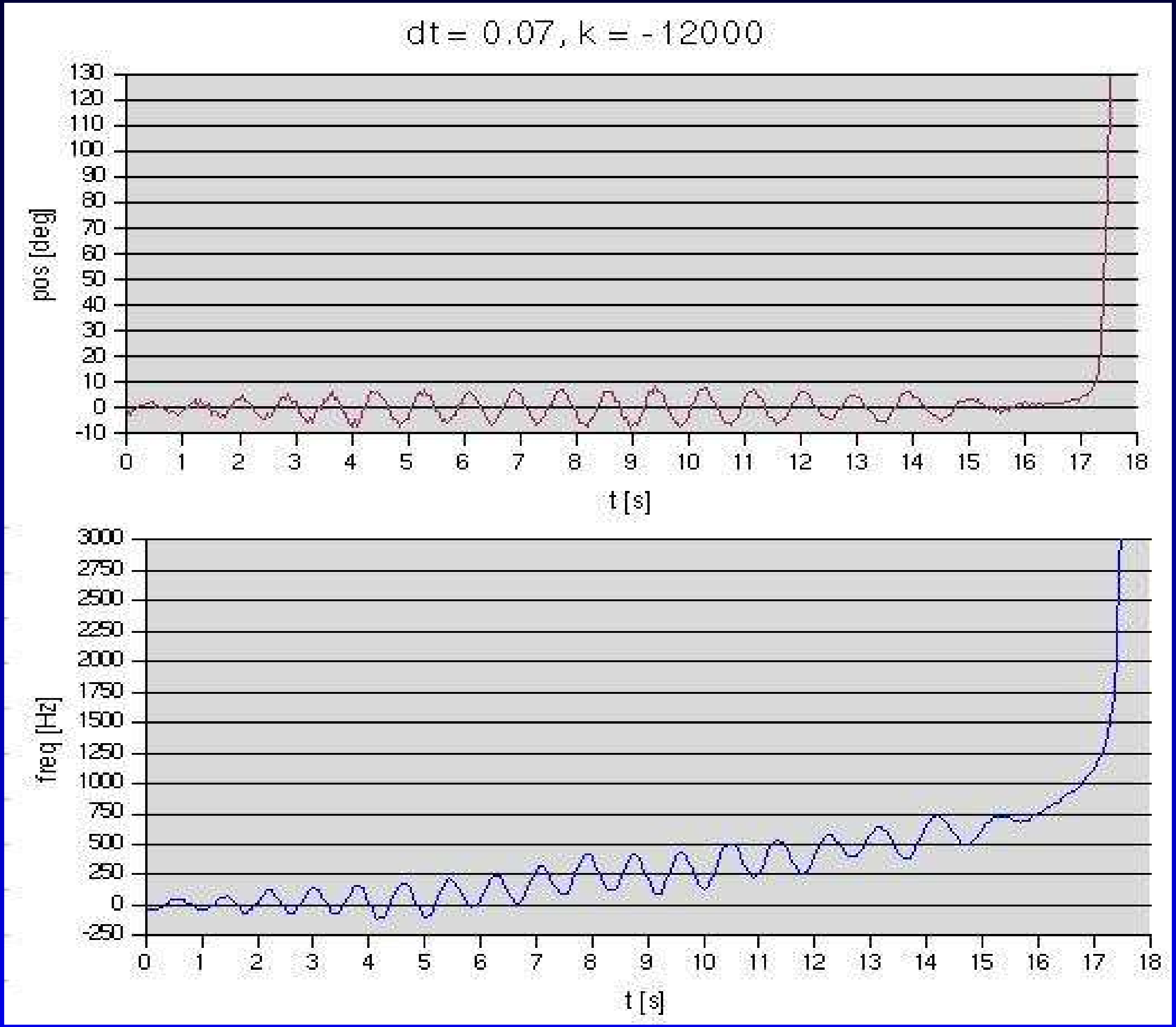
Falling



k too low

Behavior

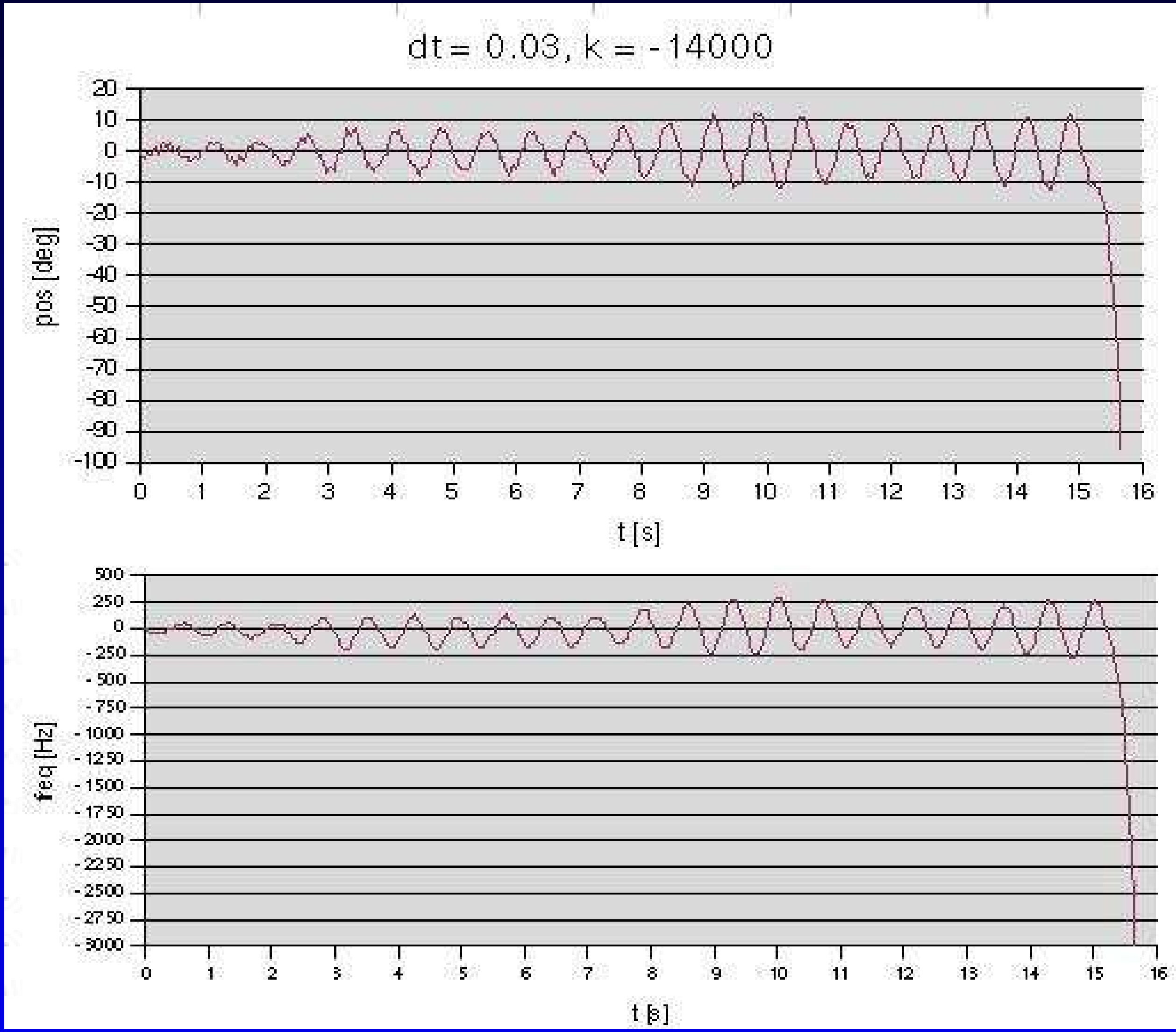
Overdrive



k too high?

Behavior

Fast Oscillations



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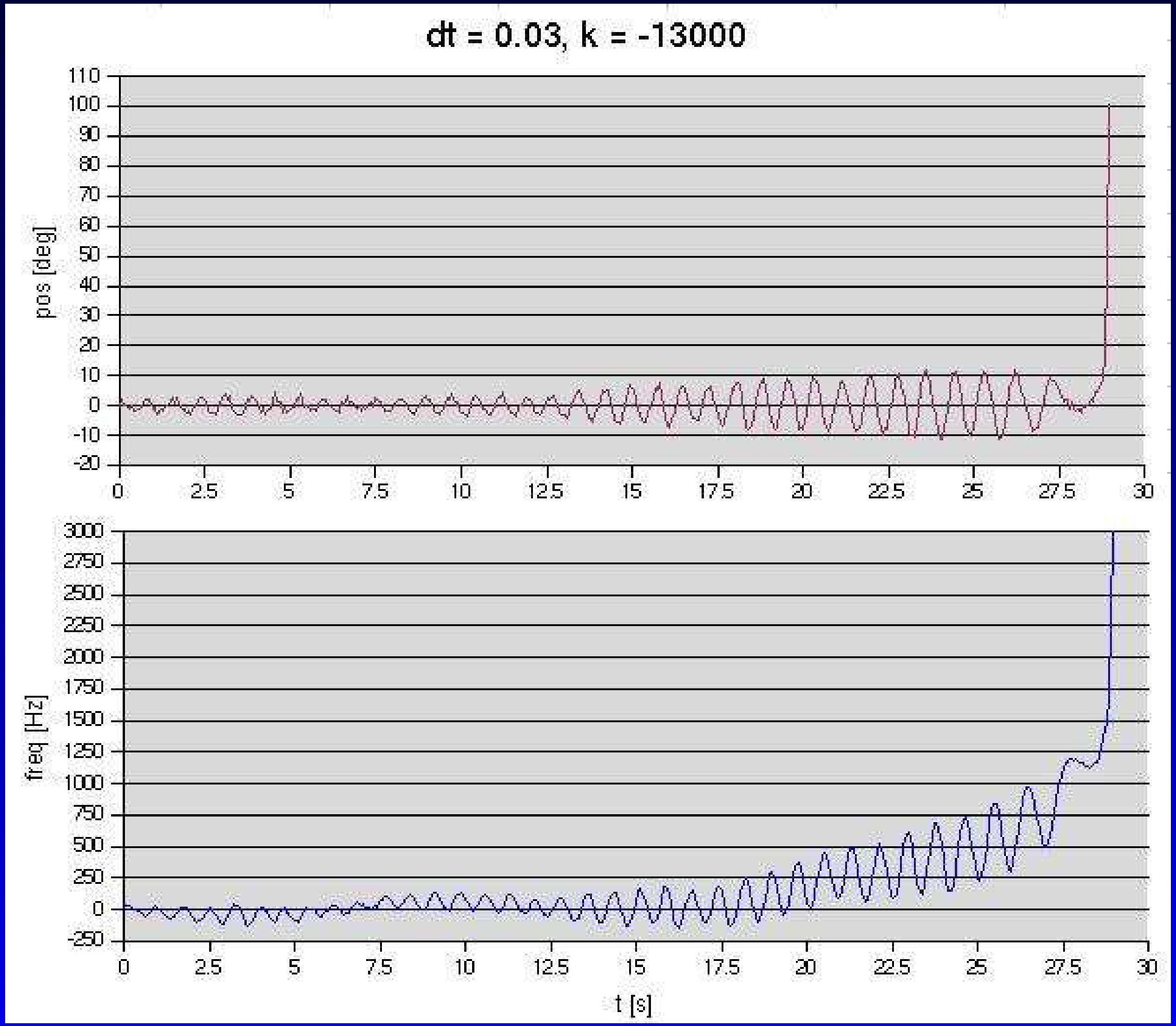
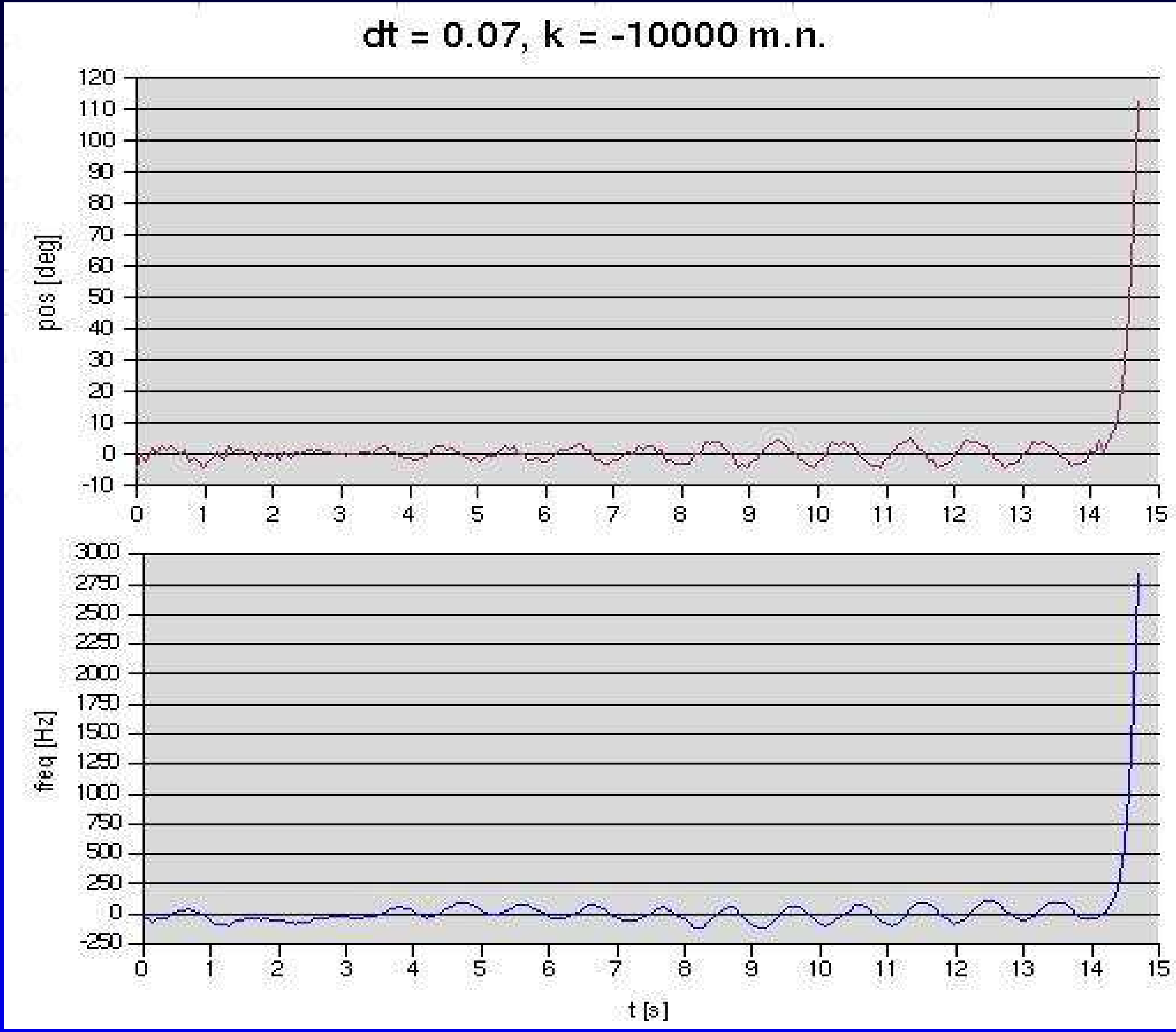
Behavior

Oscillations



Behavior

Just Giving Up



It's the motor's fault

Conclusion

- Algorithm seems to work, but not consistently
- Problems could lie in apparatus
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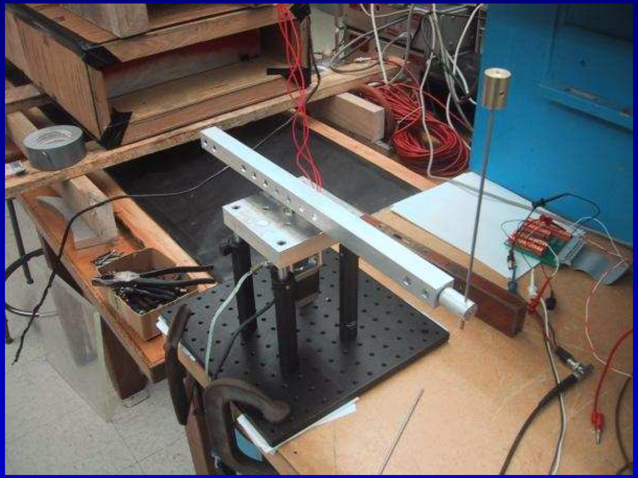
- Need something to compare data to, simulation
- The first steps towards battlefield robots have been fun!



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