Implementation of Conventional and Neural Controllers Using Position and Velocity Feedback

Progress Report 2

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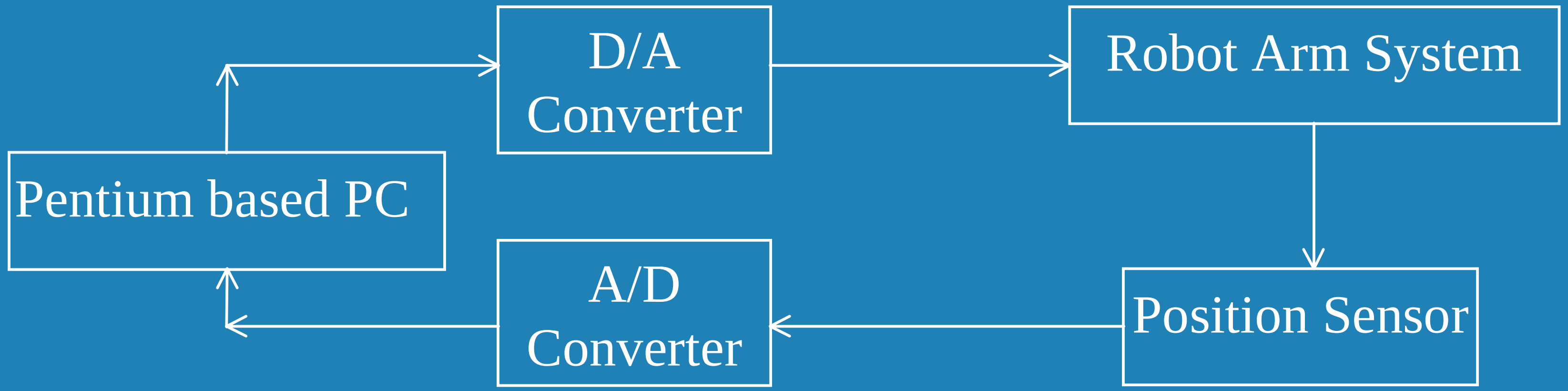
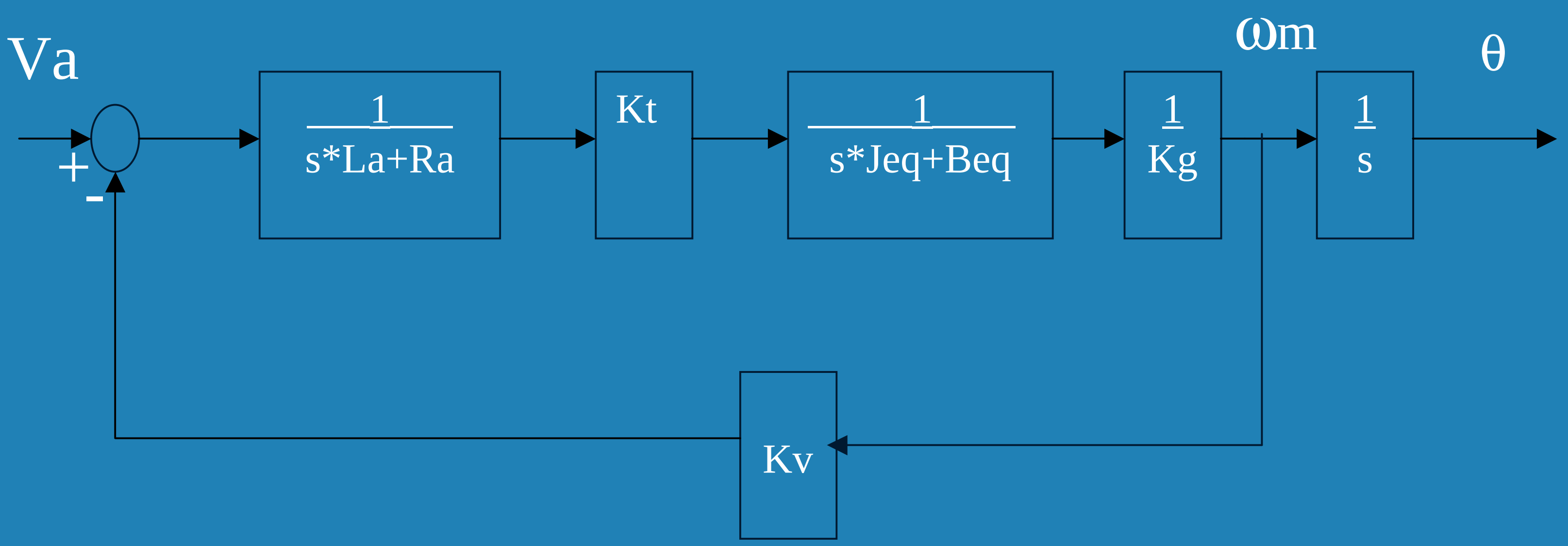
Summary

- Design and Compare Conventional and Neural Controllers for a Small Robot Arm
- Position and Velocity Feedback Design
- User Friendly Interface Design

High Level Block Diagram



Robot Arm System Block Diagram



Ra=2.6Ohms La = 0.18mH Gives a pole at 340Hz

Kt=0.00767Nm/amp Kv=0.00767V/rad/sec Kg = 1/70

Power Amp pole at 60kHz

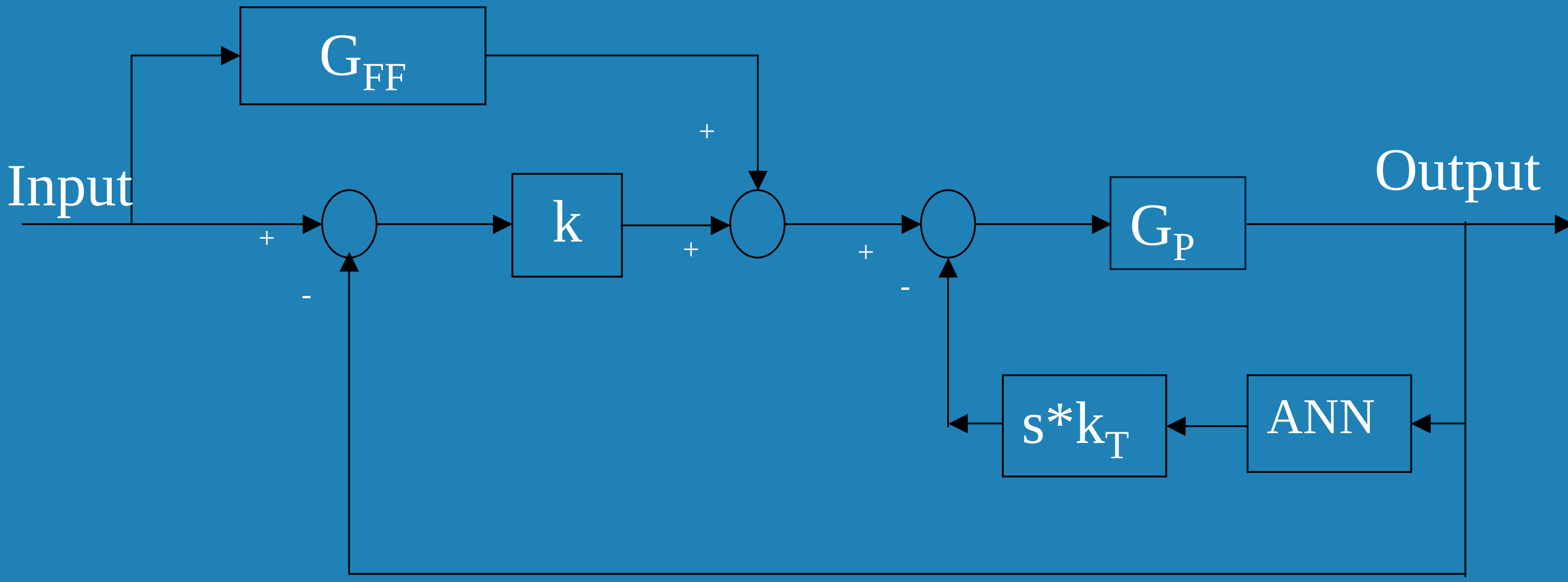
Progress

- Controller Design
  - Proportional
  - Feed Forward
  - Minor Loop
- Neural Network Curve Fit
- Velocity Algorithm

Controller Design

- Proportional Controller
- Feed forward Controller
- Minor Loop Controller
  - Neural Network Curve fit for noise Cancellation

Control Block Diagram



$$Gp = \frac{5.05 * e^{-0.025s}}{s(s/2+1)}$$

P-Controller

- Design 10% overshoot
- K= 0.256

Feed Forward Controller

- Take invers of Plant
- Choose 1st order with good pole
- Adjust K with real system

$$G_{FF} = \frac{s}{(s/10+1)*5.05}$$

Feed Forward in C-Code

- The Programming Equation is

  Y=1.9319X-1.9319X_P+0.95122Y_P

- Added features to the user interface

Minor Loop Controller (Tach)

- Design for 60 degree Phase Margin
- Adjust Pole

$$G_{ML} = \frac{s*0.212}{s/30+1}$$

- Adjust Gains of Proportional and Feed Forward

Feed Forward and Gain

- The Feed Forward Controller is now

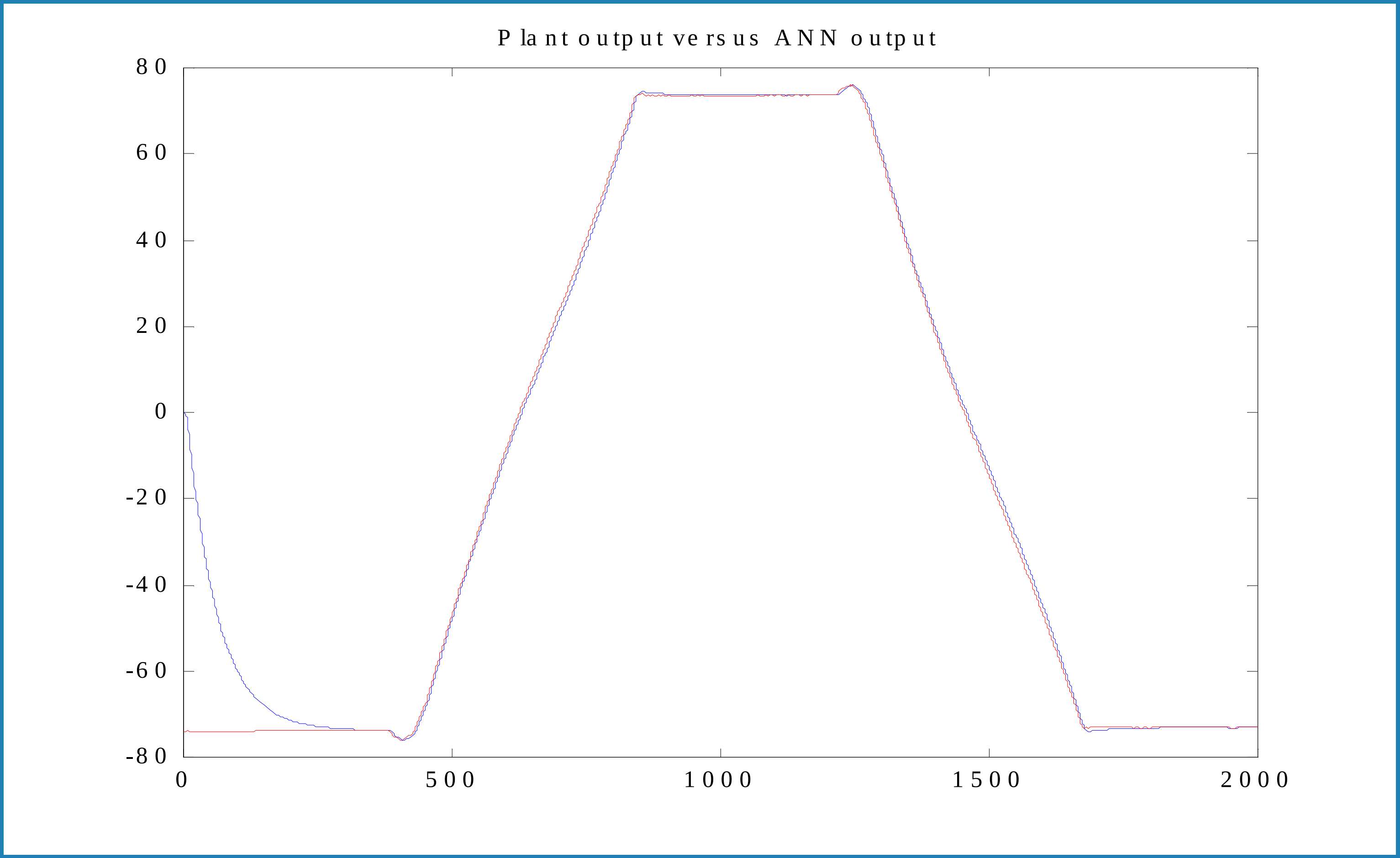
$$G_{FF} = \frac{0.3 * s}{s/30 + 1}$$

- Gain K is 0.42

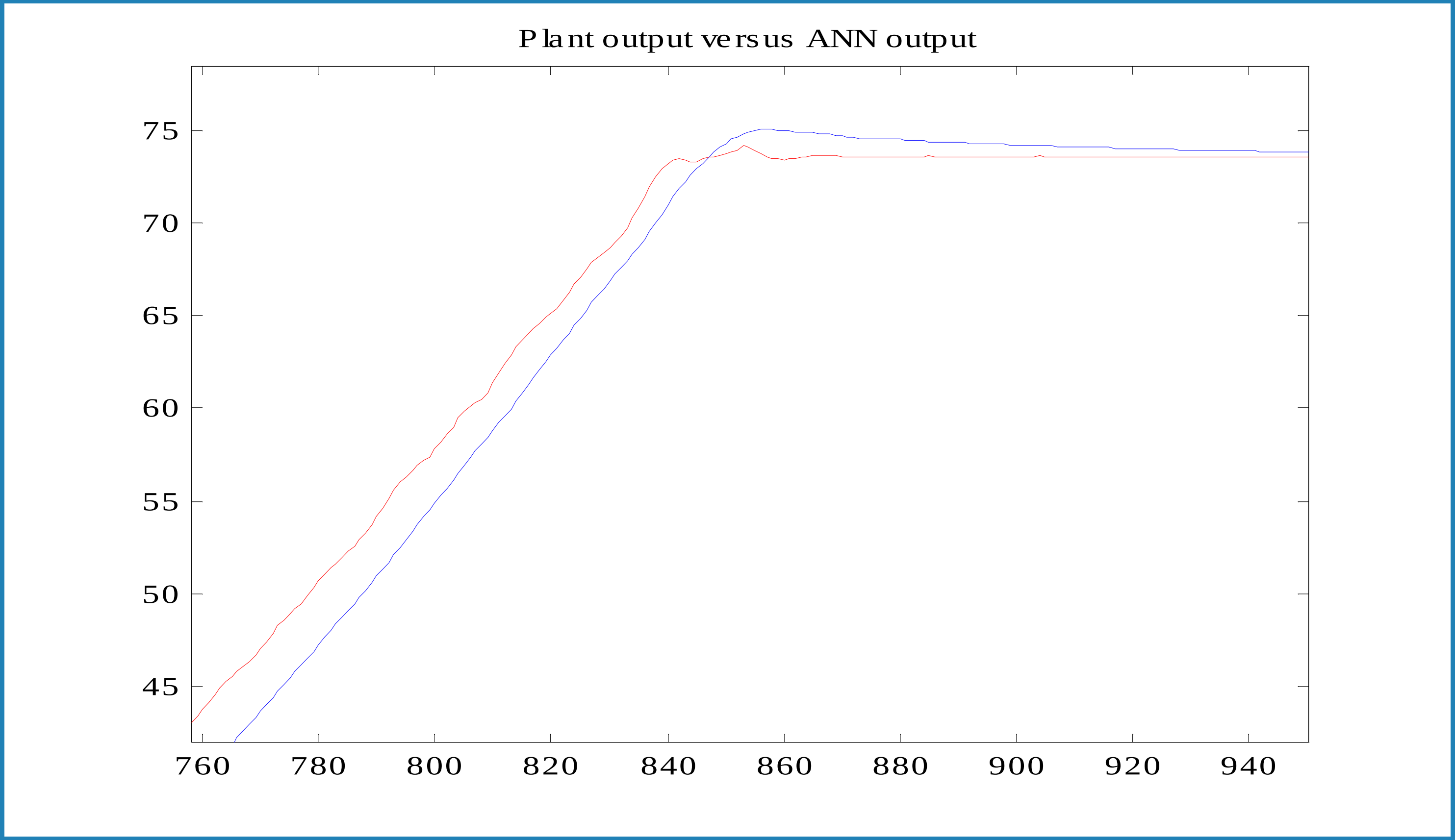
Neural Network

- Curve Fit of Motor Position (Cancel Noise)
- $\eta=0.0000002$
- 16 inputs
- 1 neuron (Adaline)

Plant versus ANN Output



Plant vs. ANN enlarged



Velocity Algorithm (Differentiation)

- Backward Propagation

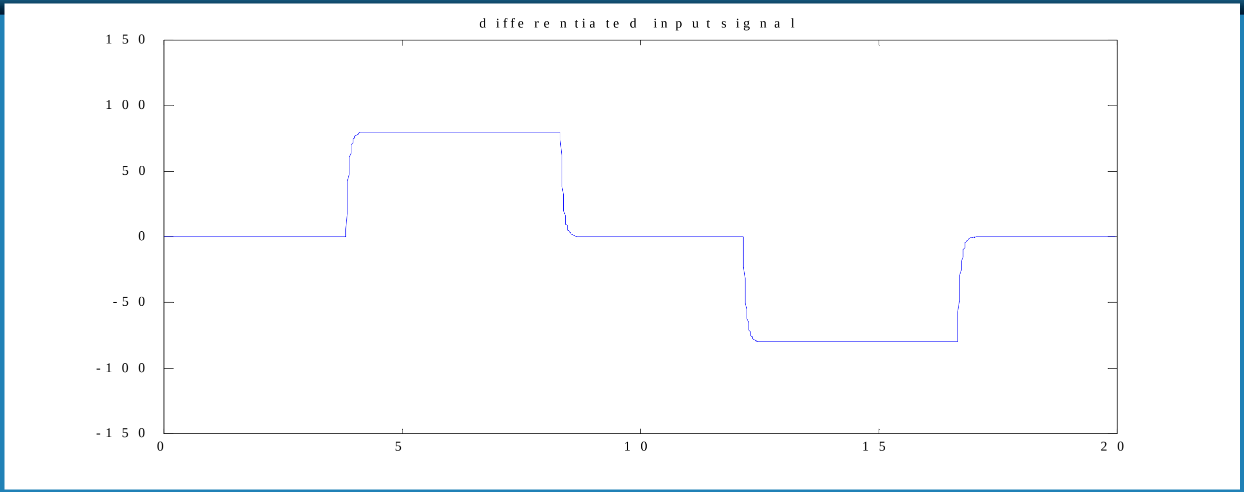
$$F(z) \rightarrow \frac{z-1}{Tz} \rightarrow F'(z)$$

- Tustin's Method

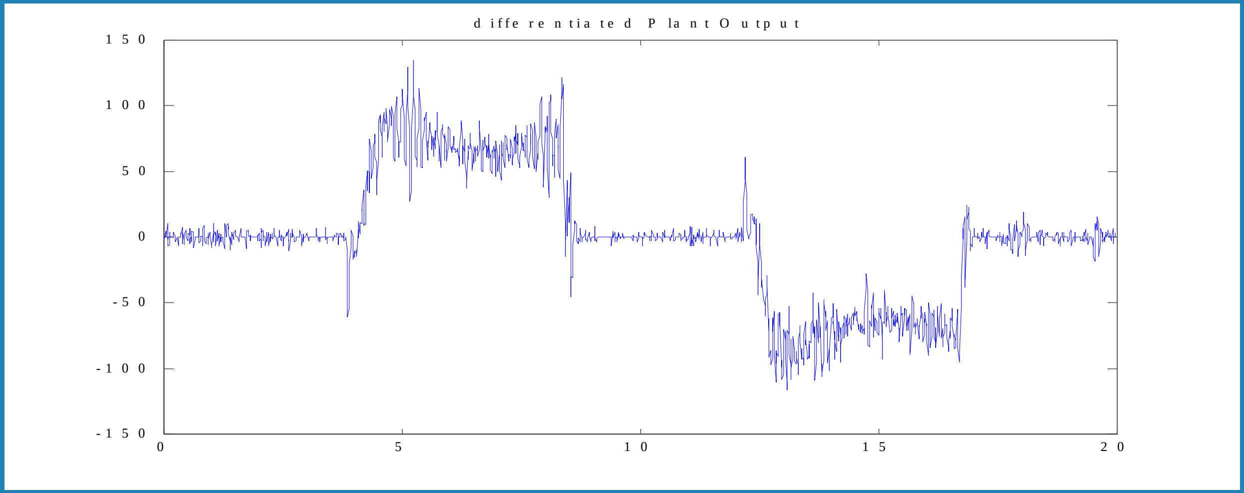
$$F(z) \rightarrow \frac{2}{T}\frac{z-1}{z+1} \rightarrow F'(z)$$

Differentiation of Step Ramp Function

Ideal



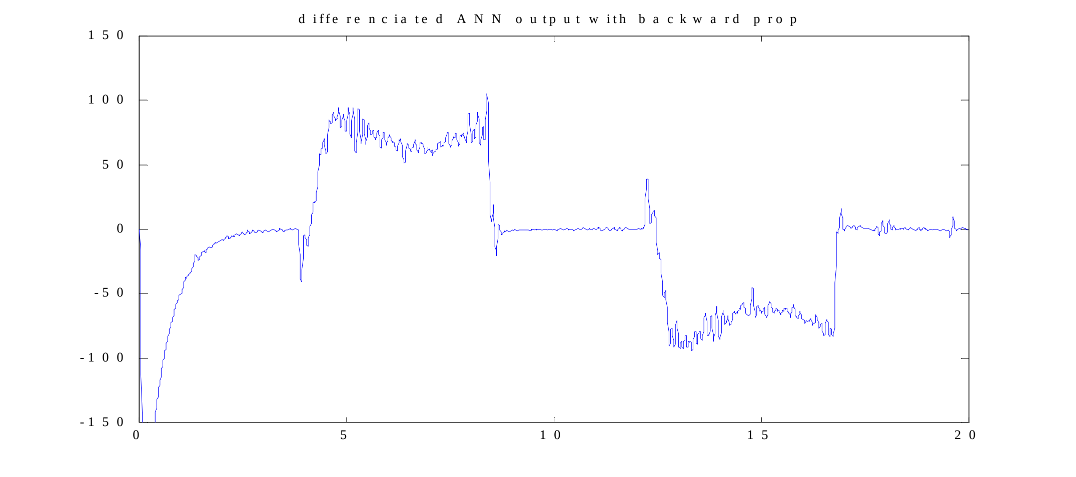
Plant diff. w/o ANN



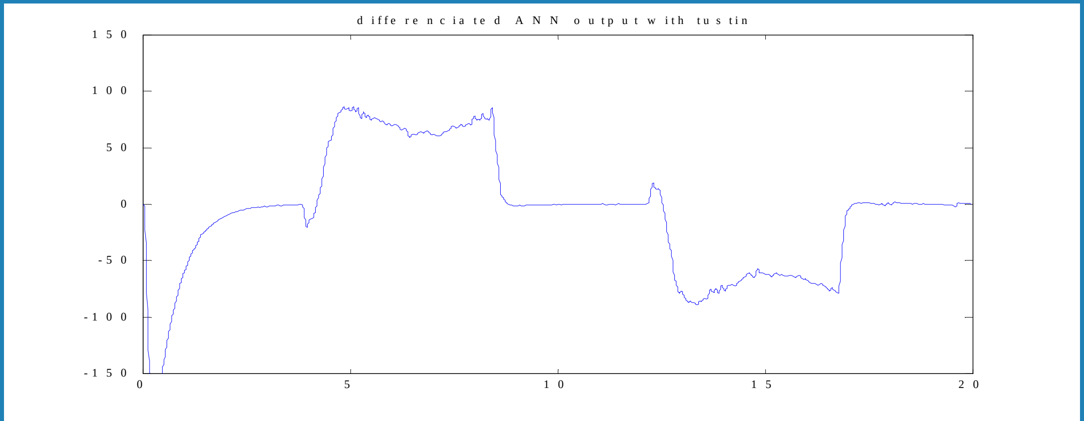
Differentiation Methods

Backward

Rule



Tustin



Results

Noise Cancellation---> ANN

Velocity Calculation--->Tustin

$$K_{\mathrm{Pr}} = 0.42$$

$$G_{ML} = \frac{s * 0.212}{s/30 + 1}$$

$$G_{FF} = \frac{s * 0.3}{s/30 + 1}$$

Revised Schedule

Subproject	Time in Weeks	Progress
System Identification	3	Done
Menu	1	Done
P-Controller Design and Testing	1	Done
Two Loop Design Without Neural Network	2	1 Week left
Velocity Algorithm	2	Done
Two Loop Design With Neural Networks	1	Not Started
Feed-Forward Control	1	Done
Digital Control Analysis	1	Not Started

The

End