

Project Progress Report

Implementation of Conventional and Neural Controllers Using Position and Velocity Feedback

Week Ending: March 5, 2000

By:

Chris Spevacek and Manfred Meissner

Advisor:

Dr. Gary Dempsey

Signature: _____

Grade: _____

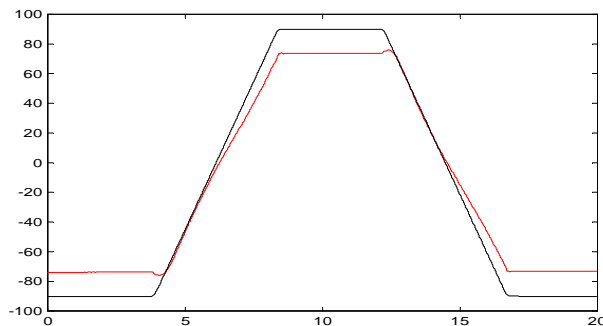
Objective

This week's objective was to start with the neural network approach to cancel the noise of the motor and power supply (Manfred) and improve the Feed Forward compensator (Chris).

Progress

Neural Network:

Since the output of the motor is noisy and we wanted to differentiate the position signal to get the velocity we first had to smooth the output to get rid of the noise spikes.



In Fig.1 it can be seen that the plant does not follow the input signal and that there is a lot of noise, which will be even worse if we differentiate it.

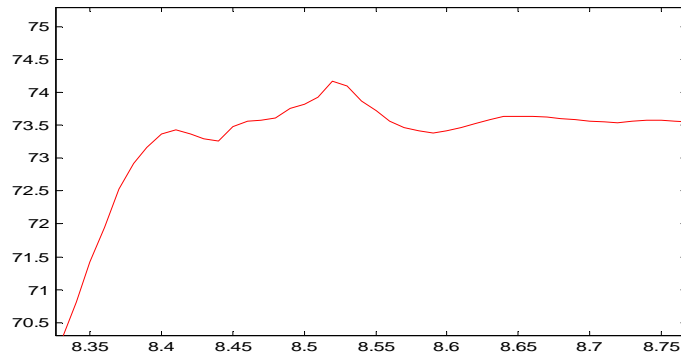


Fig.2 Blow up of plant output

The purpose of the Artificial Neural Network (ANN) is to make a curve fit so the output signal is smoother. After various attempts a learning rate $\eta=0.0000002$ and 16 inputs were selected. A slower learning rate would take too long to follow the signal and a learning rate too high would not be able to follow the plant signal. The inputs were chosen to be 16 since a lower input number would not smooth the curve enough and an input number too high takes too much computation time since the ANN is fully connected.

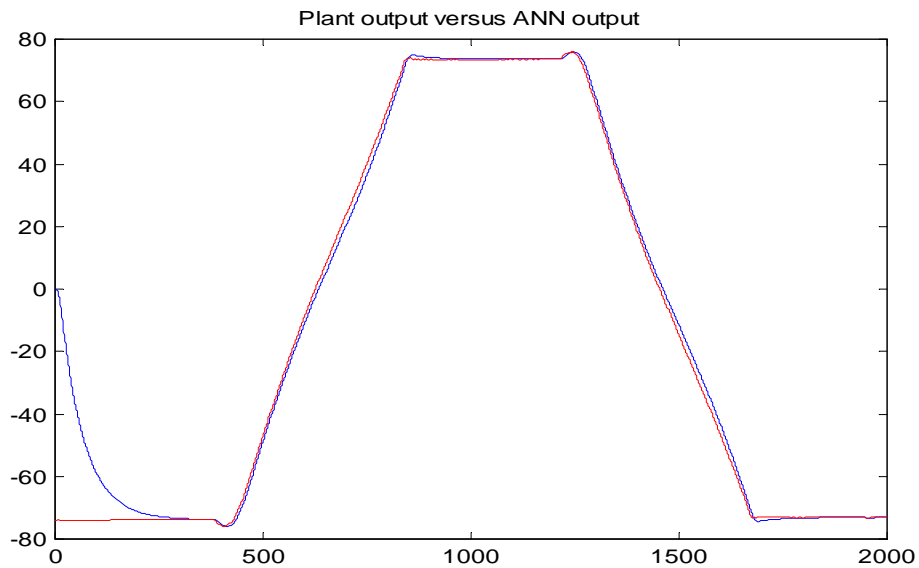


Fig.3 Plant versus ANN output

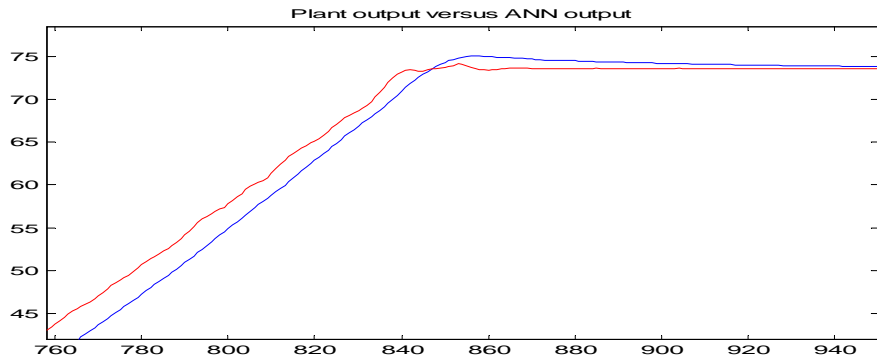


Fig.4 Blow up of plant versus ANN output

In Fig.4 the curve fitting of the ANN can be observed. Not that the spikes are almost gone and we can now run the different differentiation algorithms. The ideal output is shown below:

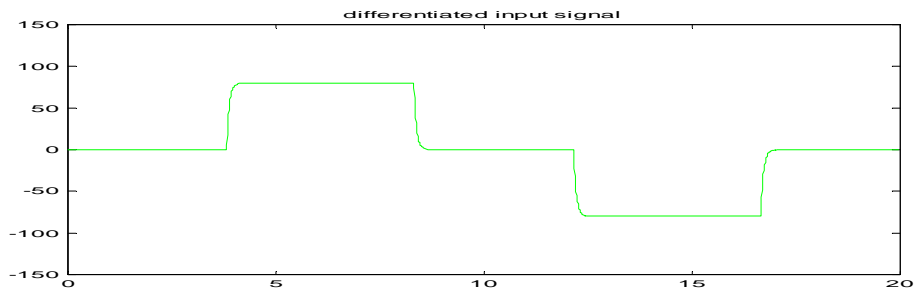


Fig.5 Ideal differentiation of input signal

Using backward propagation rule:

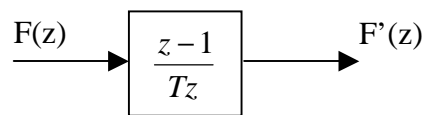


Fig.6 Backward rule for differentiation

Using Tustin's method:

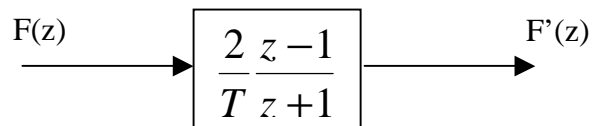


Fig.7 Tustin's method for differentiation

The next graphs will show the improvements using various differentiation rules:

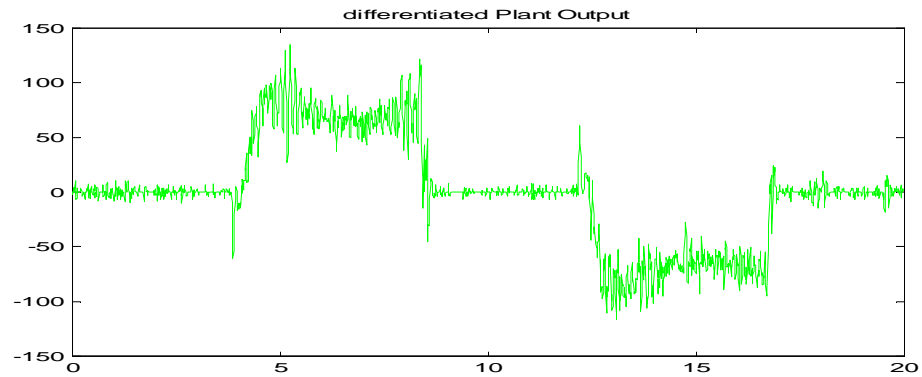


Fig.8 Differentiated Plant signal without ANN

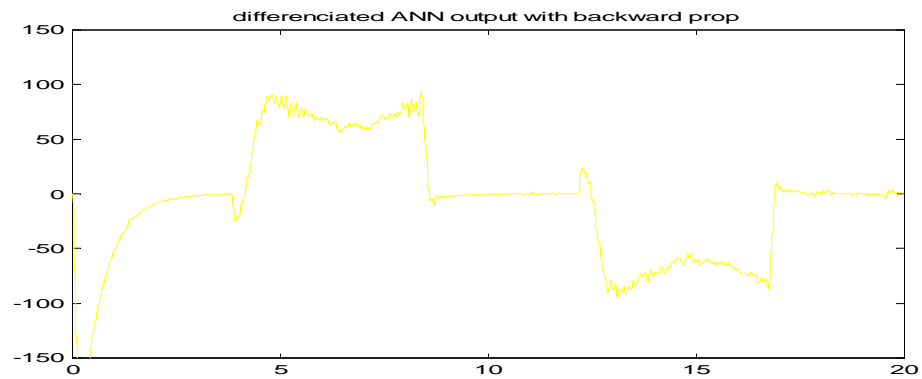


Fig.9 Differentiation with ANN and backward rule

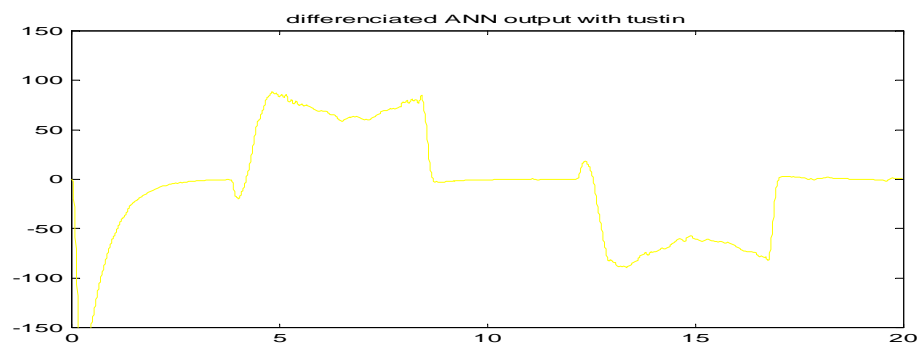


Fig 10 Differentiation with ANN and Tustin's method

In conclusion we will use Tustin's method for differentiation of the position output to get the velocity.

Feed Forward:

The feed forward network had to be redesigned for the configuration shown in Fig. 11. First the feedforward compensator was designed using the plant inverse this gave us a good tracking but the voltage going in to the D/A was above 5V. To counter that the gain of the compensator was lowered until we had just below 5V going in to the D/A converter. When this was changed the tracking was not there anymore.

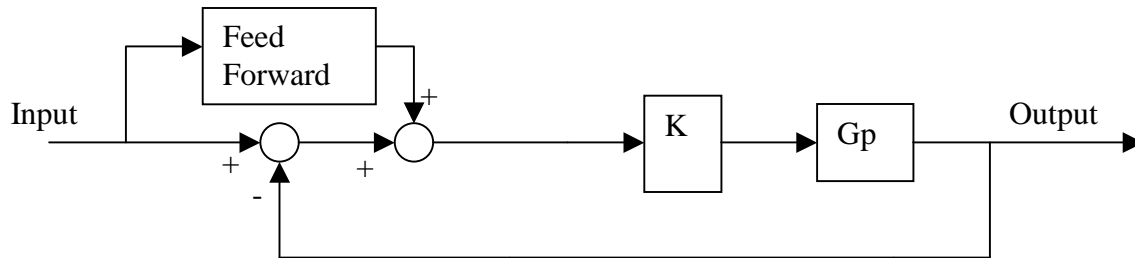


Fig. 11 Feed Forward K-Controller

So a first order system was used for the plant, to do this a pole had to be added at 10rad/sec, the feed forward compensator is

$$Gf = \frac{s}{s/10+1} \quad (1)$$

This was tested and still has to be fine tuned. The tracking was great with a feed forward gain of 1. But the D/A volt is still to high. The final tuning will be done at the beginning of next lab.

An error was also found in the program that if the C-program is ran the command signal does not work. If the ramp velocity is changed nothing happens to the moter speed. The motor speed should decrease if the ramp velocity is decreased. The only thing that changed the speed was the step frequency. Trying to figure this problem out took most of the afternoon. So the feed forward compenstor could not be implemented in C-Code. This will be done in the next lab period if the error can be fixed.