Project Progress Report

Implementation of Conventional and Neural Controllers Using Position and Velocity Feedback

Week Ending: February 13, 2000

By:
Chris Spevacek and Manfred Meissner

Advisor:
Dr. Gary Dempsey
Signature:_______________________
Grade: ________________

Objective

The objective for the week was to finish the system identification of the robot arm system with a small arm.

Progress

Since the second pole of the plant was not found we assumed a first order system with time delay (1).

$$Gp = \frac{K e^{-std}}{s} \qquad (1)$$

The plant in reality looks different and is derived from the following block diagram as shown in Fig. 1.

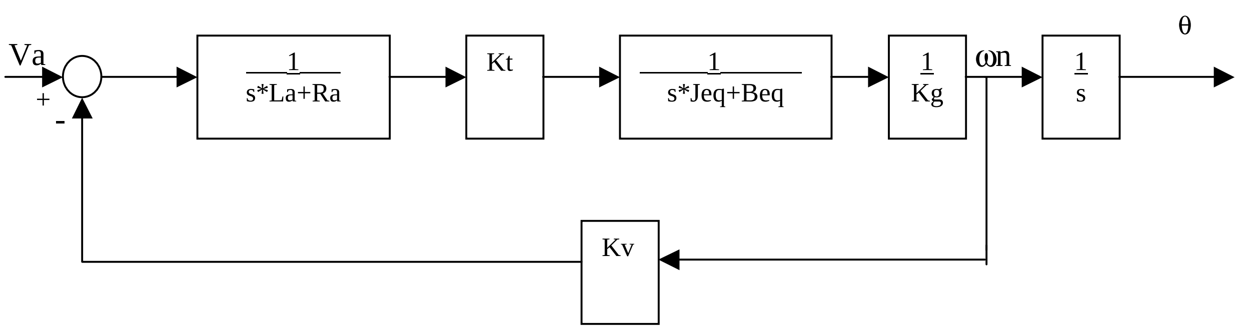

Fig. 1. Robot Arm System Block Diagram
DC Motor with Robot Arm Load

In this block diagram, 3 poles can be seen. One for the integrator, one for the J-term, and one for the La, Ra term. This results in the following s-plane plot, Fig.2.

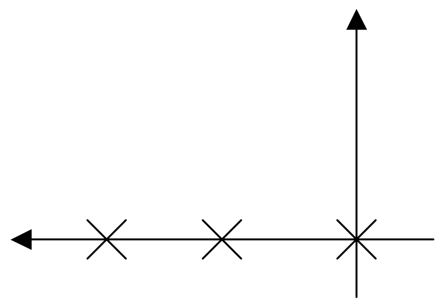

Fig. 2. Pole Zero Description

Next we tried to design a proportional controller and the outcome of last week was k=0.967. In comparison to MatLab we ran the real time simulation with step input on WinCom and displayed the output on the scope. In changing k we found the overshoot to change as expected.

Gain k	1	0.75	0.33	0.2
% Overshoot	44%	41%	10%	0%

The WinCom diagram using the real time simulation is shown below in Fig.3.

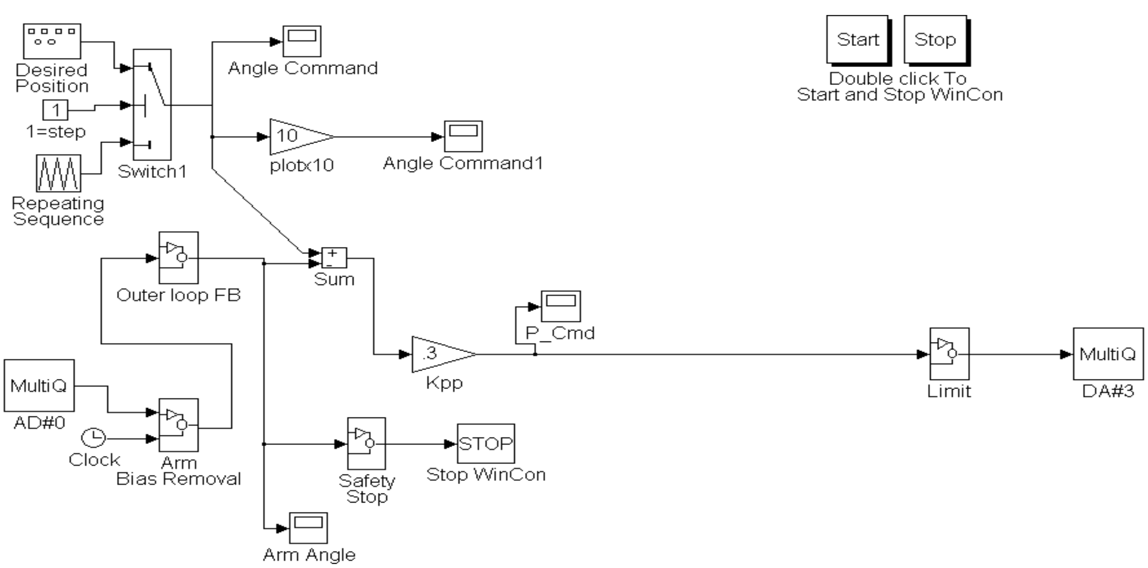

Fig.3 Closed Loop Real Time Diagram

The MatLab simulation using Simulink showed completely different results. So it looked like the assumption of a first order system model was wrong and we switched to a second order approach (2).

$$Gp = \frac{K e^{-std}}{s(s/p+1)} \tag{2}$$

The problem we ran into here was that we could not verify the second pole because of the big time delay. A trial and error approach on Simulink was made to match the experimental results with the simulation results. If it would match up we found the plant transfer function. After a lot of attempts the following plant was found to have the closest results (3).

$$Gp = \frac{6.9 * e^{-0.025s}}{s(s/3.2+1)} \tag{3}$$

Gain k	1	0.75	0.33	0.2
% Overshoot Experiment	44%	41%	10%	0%
% Overshoot Simulation	44%	36%	13%	3%

A second approach to verify our plant was considered. This approach used velocity to find the gain of the system. The revolution of the arm was timed for different voltages. With theses voltages the velocity was found and by dividing by the input voltage, the gain was determined. The table below shows the voltages, time per revolution, and gain found at each input voltage.

Voltage(Input)	Time per Revolution	Gain
4volts	12.5seconds	7.2
3volts	12.8seconds	9.375
2volts	13.0seconds	13.85

With this data we determined that the gain of the system is variable depending upon the voltage. To find the model the average was taken of the gains and found to be 10.1. To find the second pole Simulink was used by trial and error method. Different poles were substituited into the system until we found a pole that gave us the closest results to the actual system. The pole was found to be at 2 giving us a system of

$$Gp = \frac{10.1 * e^{-0.025s}}{s(s/2+1)} \tag{4}$$

Gain k	1	0.75	0.33	0.2
% Overshoot Experiment	44%	41%	10%	0%
% Overshoot Simulation	43%	35%	15%	5%

The model shown in (4), is the model of the system that is going to be used because the k was found experimentally.

Revised Schedule:

Subproject	Persons	Time(weeks)	Progress
System Identification	Chris, Manfred, and Dr. Dempsey	3	.5 week left
Menu	Chris and Manfred	1	Done
P-Controller Design and Testing	Chris	1	.5 weeks left
Investigate and Implement Neural Networks with P-Controller	Manfred	2	Not started
Velocity Algorithm	Chris	2	Not started
Two Loop Design With Neural Networks	Manfred	1	Not started
Feed-Forward Control and Implemenation in Neural Networks	Chris and Manfred	1	Not started
Digital Control Analysis	Chris and Manfred	1	Not started

One week wass added to the neural networks and velocity algorithm items. The rotary encoder work was eliminated to allow for this schedule adjustment.