ME477, Lab 8

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Description:

This program implements a closed-loop position control for a DC motor. The reference motor position through a path-planning “s-curve” limited by a maximum acceleration and velocity. A provided C function `Sramps()` generates this displacement curve. The control is then implemented through the same biquad function as in previous labs, `cascade()`, which uses the reference position and the actual encoder position to produce the correct output voltage. The PID controller itself is generated in a MATLAB script and written to a C header file.

```
main
|_ Irq_RegisterDiIrq()     - reserves interrupt, configures DI and IRQ
|_ pthread_create()        - creates new thread to service interrupt
|_ Irq_UnregisterDiIrq()   - unregisters interrupt
|_ ctable2()               - generates value display table
|
Timer_Irq_Thread           - performs function in response to interrupt
|_ printf_lcd()            - prints to LCD screen
|_ Irq_Wait()              - waits for IRQ number or ready signal
|_ Aio_Read()              - reads an input channel
|_ Aio_Write()             - writes to an output channel
|
cascade()                  - calculates the difference equation with a
|                                                     biquad cascade
pos()                      - determines relative encoder position (BDI)
|_ Encoder_Counter()       - reads current encoder count
```

Testing:

1. Run the program
2. P_ref will begin increasing in increments of 10.125 revolutions and the motor will spin up
    a. P_act will track P_ref
3. After roughly 10 seconds, the motor will reverse direction and P_ref will begin decreasing in increments of 10.125 revolutions
    a. P_act will track P_ref

Results:

The motor behaved as expected in-lab. The reference position ramped up to its final value in a series of s-shaped steps, and then turned and returned to zero. This can be seen in the position versus time plot in the figure below. The simulated theoretical results (using MATLAB lsim), the reference position, and the actual position all track each other very well. The actual position has greater error (deviation from reference position) than the theoretical position, as can be seen in the bottom left plot. The error is not high, roughly 0.5 rev. This could be due to rounding error or slight discrepancies in the laboratory setup. The experimental and theoretical torque differ more, with the theoretical torque roughly three times higher than the experimental. The graphs follow the same shape.

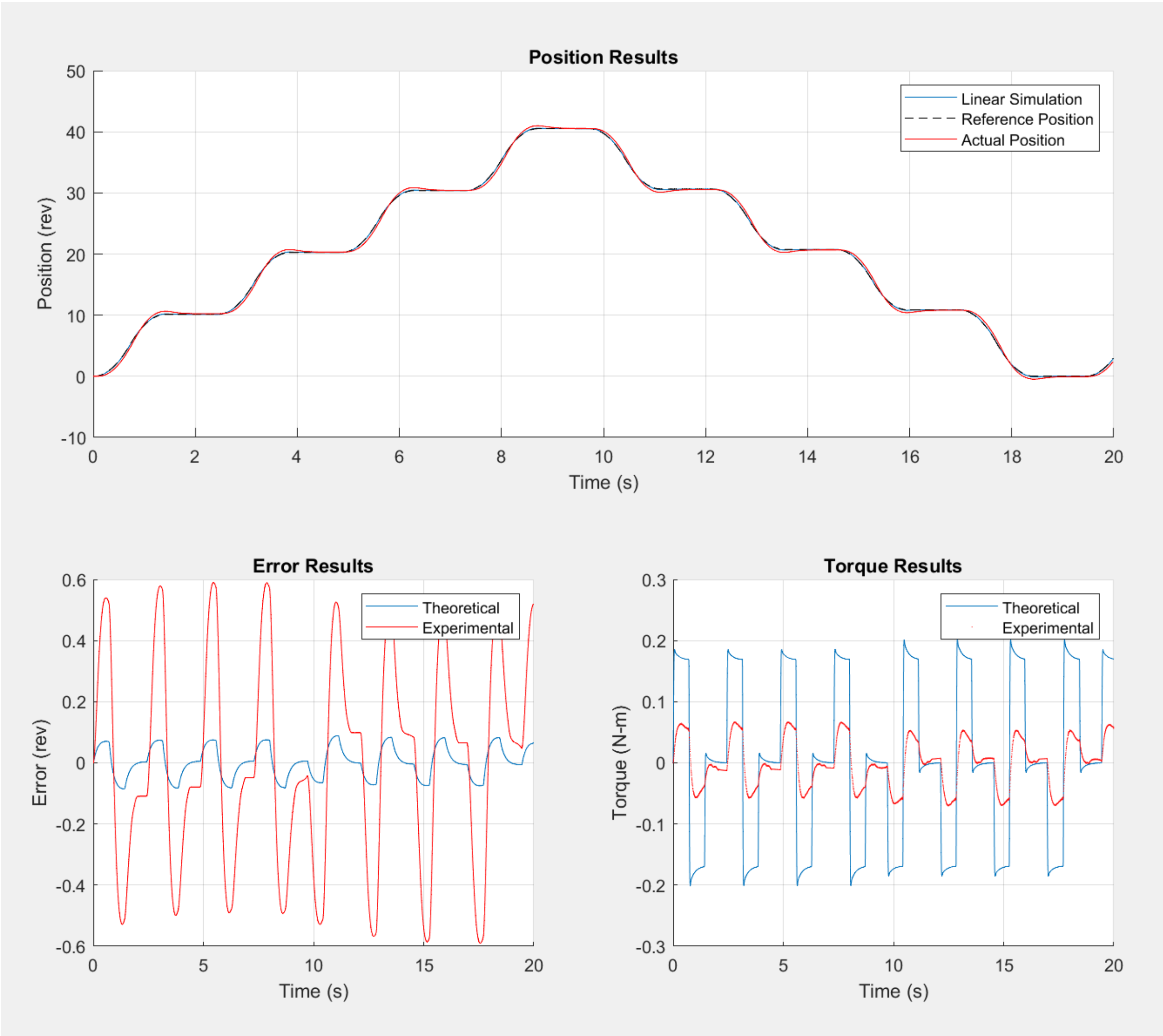

Figure 1. Position, Error, and Torque Plots