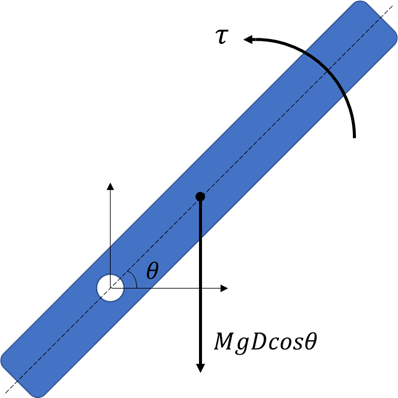
**ME-180 HW6: Logbook for myRIO Project**

**Shang Wang**

Designing a controller using state space approach.

**1. Equation of Motion for the System.**

****

**Fig.1 Load of the Motor**

Due to the nonlinear nature of the inverted pendulum, the control design must go through the linearization process.

is related to the , so the system is nonlinear, thus the compensation has to be considered to make guarantee the same response at any working point.

**Inertia:** The inertia is calculated by assuming the mass is evenly distributed in the entire linkage

Formula for Moment of inertia according to the axis at one end

Also, we will neglect the motor inertia, since the motor inertia is two order of magnitude smaller.

**Damping:**

The damping is already calculated from previous logbook by a step response of the motor, add a linkage do not affect the damping, so the damping is:

**Gravity:**

The Gravity can be calculated easily from the figure on the right,

**Linearize the model:**

First, write out The Equation of Motion for the Fig.1

Assume

Then

Linearized by:

So

Substitute back to the Equation, then the linearized equation is:

Let

Then the Transfer Function for position is:

From the previous Logbook we know the Torque is proportional to the Duty cycle,

Where is calculated from the Motor’s instruction menu.

Assume:

So the Transfer Function for the Duty cycle and position is:

**4. Design via State Space.**

Phase variables:

Write in state space representation:

Desired state space representation:

Desired Transfer Function 1:

Which has 20% over shoot

Desired Transfer Function 2:

Which has no over shoot

**5.Analysis of Error and Time Response:**

The transfer function for position is

So, for a step input to the system, the steady state error is:

**Measuring the Inertia, Damping, Gravity and Center of Mass.**

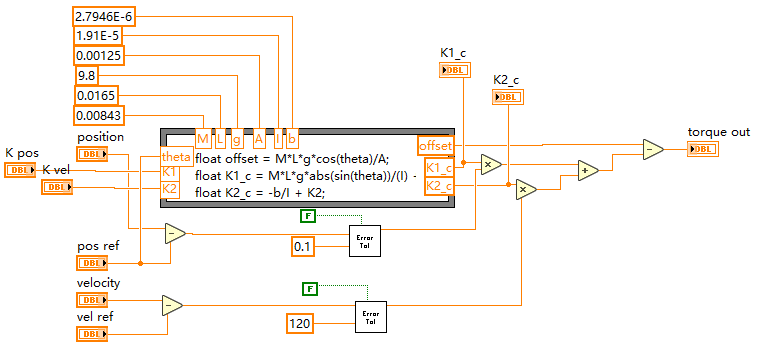
And use the Formula for Moment of inertia

**Damping:**

The Damping is already calculated from previous log book buy a step response of the motor, add a linkage do not affect the Damping, so the damping is:

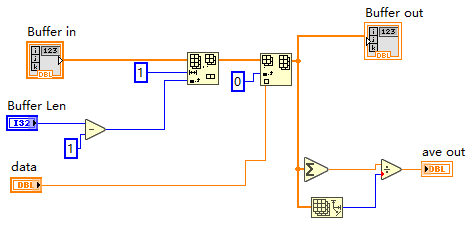
**6.Start building VI:**

Create a SubVI to compensate for the gravity term in order to calculate the torque.

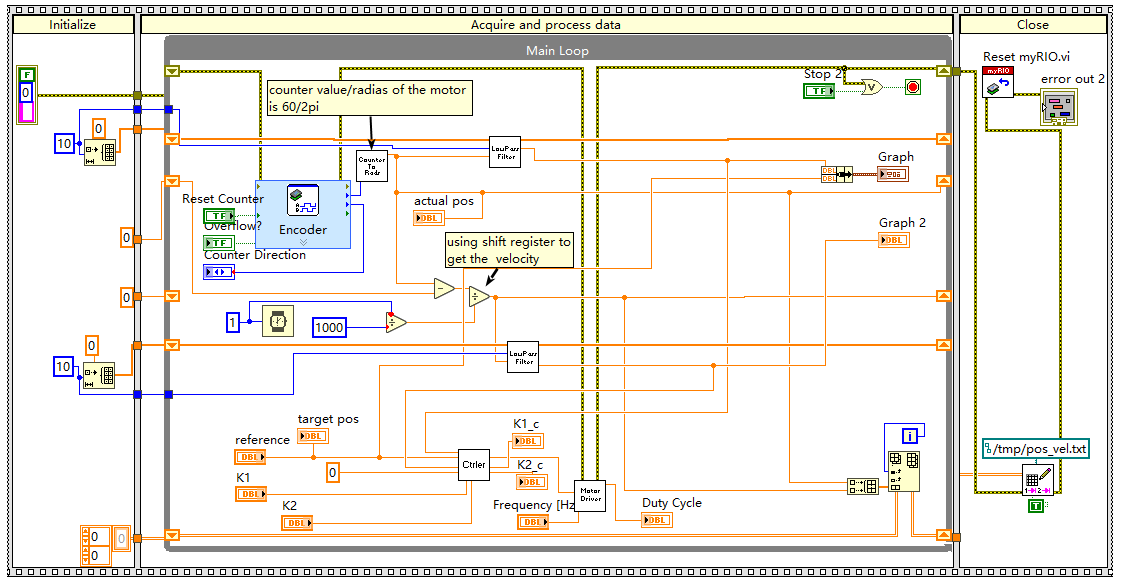


**Fig.2.1 Gravity Term Compensate**

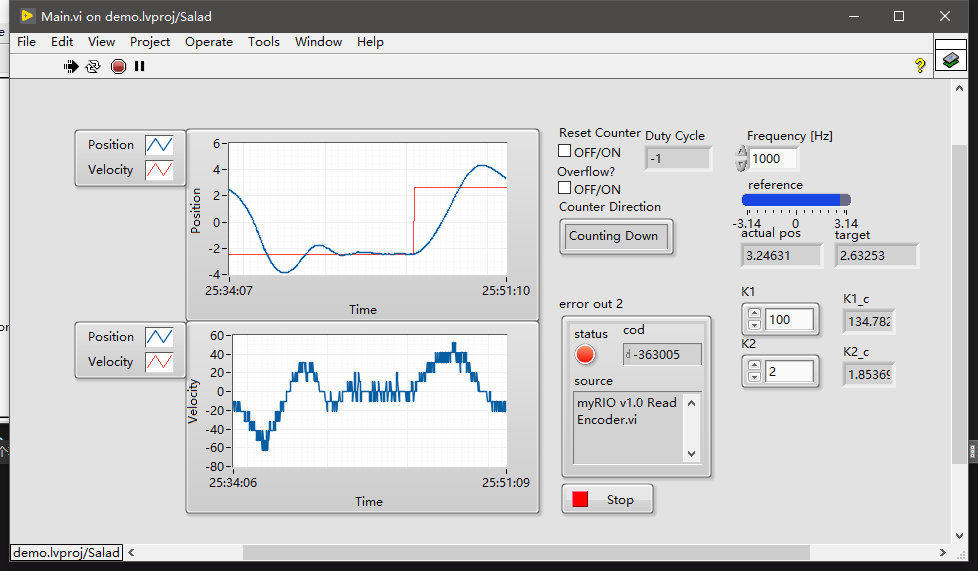
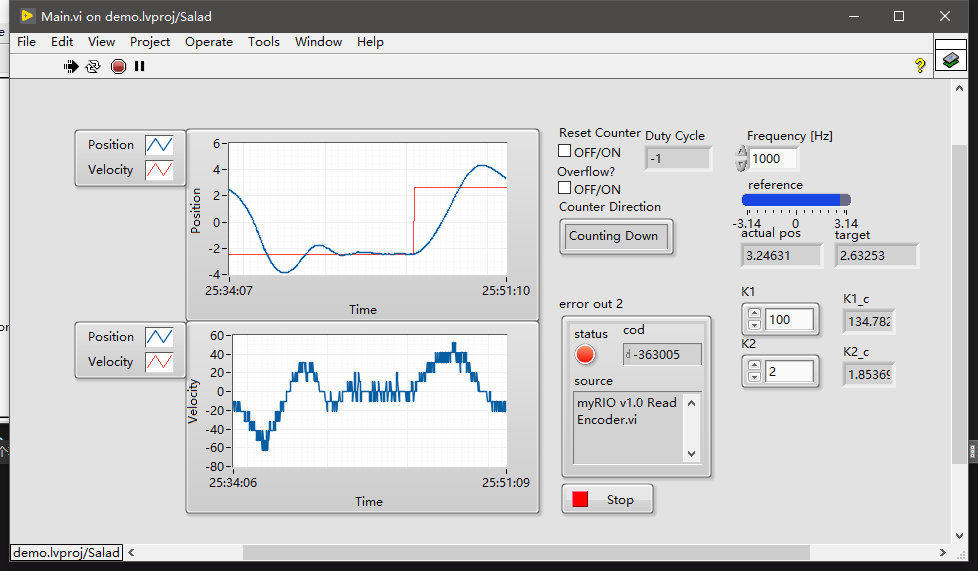
Then, make a FIFO filter to filter out the velocity in order to get a better

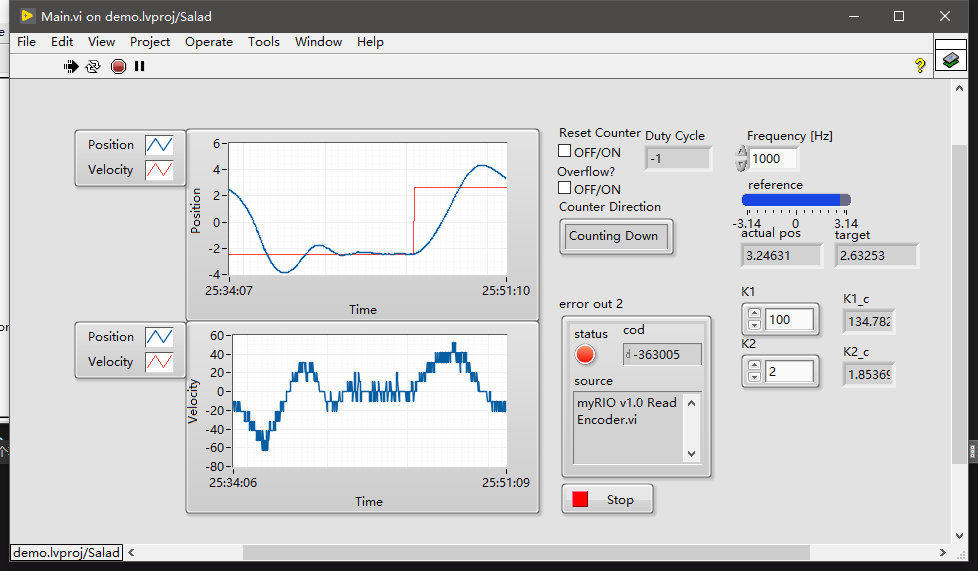


**Fig.3 Filter SubVI**



**Fig. Main Vi System diagram**.





**Fig. The Response of the System for Two Given Step input . (the lower plot is velocity)**