ME6404 – Fall 2016
# Lab 1A - Bridge Crane

Objectives:

- Develop a basic understand of the laboratory equipment.
- Change the speed of the crane.
- Record the time response of the system and measure the effect on the pendulum swing.

Lab Tasks:

Move the crane trolley a set distance using 3 different speeds. You will be giving the crane a pulse velocity command, as illustrated by the dashed line in Figure 1. However, due to the acceleration limit, the actual velocity of the crane will be a trapezoid, shown by the solid line. Speed is specified in terms of percent, with 100% being 0.200 m/s. Acceleration and deceleration are approximately 1.00 m/s^2. Use speeds of: 30%, 60%, and 100%.
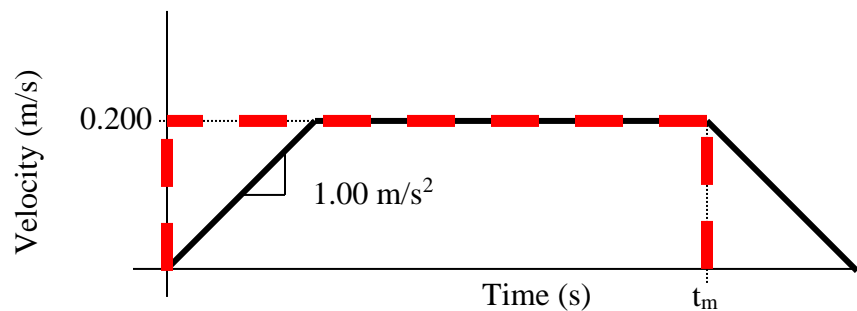
Figure 1: Drive System Velocity Profiles: Command – dashed, Actual - solid

For each trial, move the trolley 30 cm. Move in one axis/direction (bridge or trolley). Given that each trial uses a different velocity, the move time in each case will be different.

1. Calculate the move time, t_m, for each of the three speeds. Figure 1 shows the move time, t_m, in relation to the velocity profile. Keep in mind that the ramp acceleration is constant for all three cases.
2. Execute the velocity profiles on the crane and record the results.

Lab Procedure:

Bridge crane operation
1. Open the shortcut "**Bridge Crane GUI**" on the desktop. The interface shown in Figure 2 will appear.
2. To begin moving the crane, press the **Start/Stop** button (**M**) on the GUI.
3. Use the arrow buttons (**F**) to move the trolley, and the hoist buttons (**G**) to hoist/lower the hook. Make sure the Shaper button at (**D**) is "**On**" for any tests you do and **"Off"** for just driving the crane around.
4. Make sure the cable length is approximately (within 1cm) **105 cm** (center of payload to center of hoist drum). Adjust this length at (**G**) and you can see its value at (**E**)
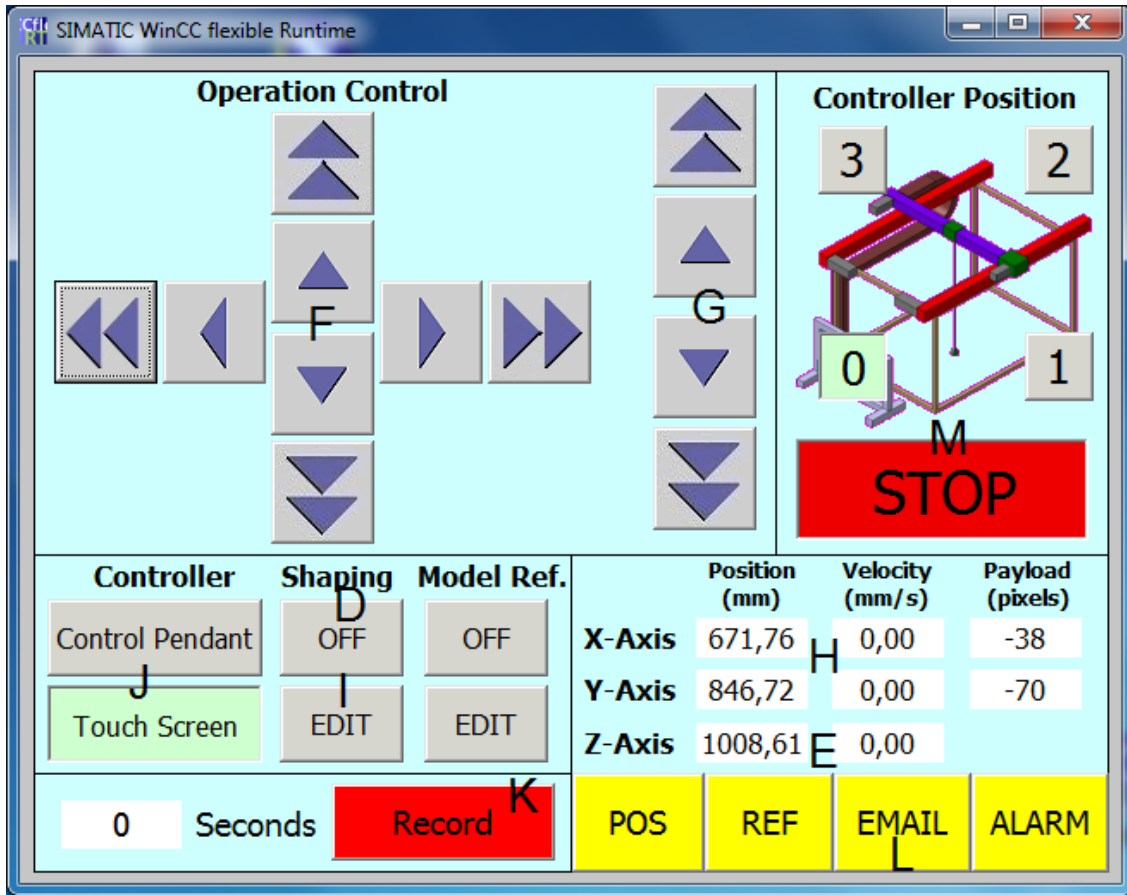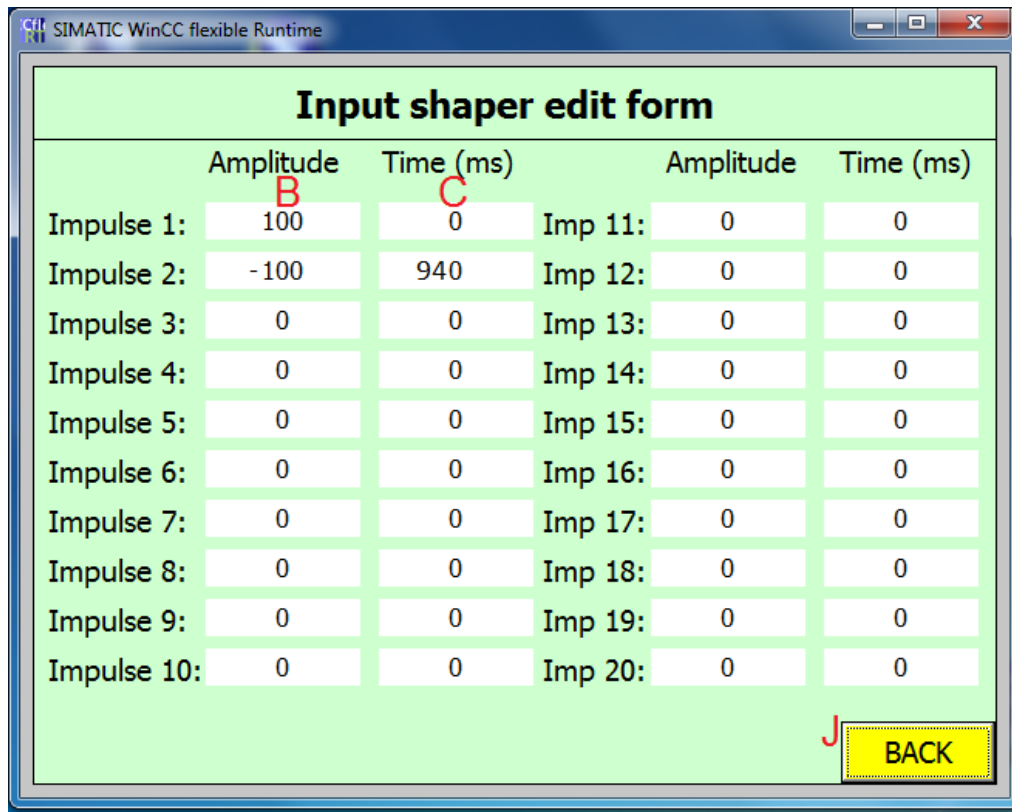
Figure 2: Bridge Crane GUI

5. Manually position the crane such that during the test, the trolley has enough room to move 30 cm without hitting an edge of its workspace.
6. Click the button labeled **"Edit" (I).** This will allow you to modify your velocity profile.
7. Referring to Figure 3, the values in **(B)** specify the speed of the velocity profile, in percentage. The second value should always be equal to the negative of the first. The values in **(C)** determine the length of the velocity profile. The first number should always be zero, and the second number is the move time, t_m, in milliseconds.
8. When you are done entering data to a field, make sure to click Enter to save. Go back to the first screen shown in Figure 2, by clicking on **"Back" (J).**
9. Use the velocity profile by switching the shaping button **(D)** to **"On"**. The crane is now ready to execute the pulse velocity command that you have designed.
10. To record your response, click **"Record"** in **(K)** to begin recording. Make sure the hook is not swinging. **(Note: please do this action from the computer only as the touch screen cannot actively connect to the internet to send the data back to you.)**
11. HOLD down a directional button on the GUI. The crane moves for the specified time and stop. When you RELEASE the directional button, the crane moves back to where it began. **(Note: buttons with two arrows use the full velocity while buttons with one arrow only use one half the velocity you set)**

12. The crane automatically stops recording after about 60 seconds. Therefore, it may be unnecessary so press **"Stop"** when you are done. Record about 4-5 oscillation periods.

13. Click **Email (L)** to send yourself the results in Excel .csv file format (this takes a few seconds). Process the data from that file as you see fit. **(Note: This cannot be done on the touch screen as it does not have an active connection to the internet. Please make sure to email data from the computer only.)**

SIMATIC WinCC flexible Runtime					
Input shaper edit form					
	Amplitude B	Time (ms) C		Amplitude	Time (ms)
Impulse 1:	100	0	Imp 11:	0	0
Impulse 2:	-100	940	Imp 12:	0	0
Impulse 3:	0	0	Imp 13:	0	0
Impulse 4:	0	0	Imp 14:	0	0
Impulse 5:	0	0	Imp 15:	0	0
Impulse 6:	0	0	Imp 16:	0	0
Impulse 7:	0	0	Imp 17:	0	0
Impulse 8:	0	0	Imp 18:	0	0
Impulse 9:	0	0	Imp 19:	0	0
Impulse 10:	0	0	Imp 20:	0	0
				J	BACK

Figure 3: Velocity Profile Design

Analyzing the Downloaded Data

- Ensure that the computer is connected to the internet to enable E-mailing. If wifi is unavailable, press function-F3 to enable wifi and connect to GTwifi.
- If wifi is enabled and you get the error "server does not support secure connections" go to the following file location after pressing the EMAIL button and manually retrieve the GT_BridgeCrane_data.csv file. C:\BridgeCraneData\Download\vba
- Note the actual velocities in the csv file are in mm/s.
- The camera is working properly if the position numbers are showing up for the x and y axis. You also need to set the correct cable length in the GUI.
- **If you cannot move the crane** even with the start button pressed, click the **"Alarm"** button in the lower right corner and clear all the warnings. If this doesn't work please make sure that the button for **"Touch Screen"** is pressed down. Toggling this button between touch screen and control pendent gives control to either device.

Book Sessions Using Google Calendar

- Login: me6404gatech@gmail.com, password: singhose6404

3

- Book your session in the appropriate calendar under "My calendars". Be aware that the lab may be unattended during early morning or late evening hours. Email the TA with any issues or concerns.

Lab writeup:

Discuss your work in less than 1 page of text. Include only relevant graphs to demonstrate your conclusions.

The text must cover:
- what you did
- what were the results

Following the text should be a set of plots. The plots must include:
- the crane velocity time history for each of the 3 tests
- the payload oscillation for each of the 3 tests

You should think carefully about the plots that you include in your report – these must be neat, clear, non-redundant, and convey the desired message in an efficient manner. Use large fonts and labels on the plots so that they are easy to understand. Furthermore, in the text, you should comment appropriately on the plots and say what is significant about them. A sample graded report is included on the following page. Please avoid the problems indicated on the report.

The Report is due at the Beginning of Lab Next Week.

Generally try to avoid 1st person in technical reports. But, something like, "We performed experiments to determine..." is OK

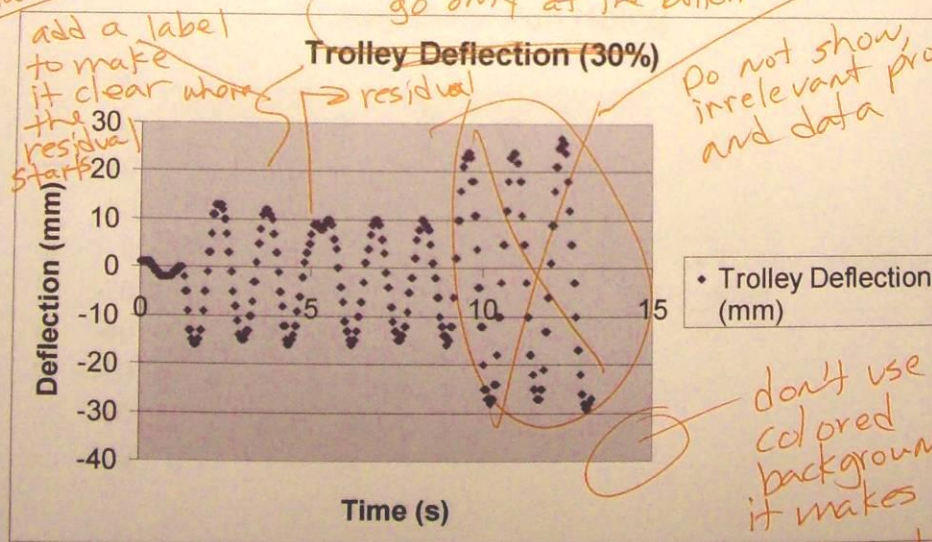*Do not refer to multiple plots all at the same time. Introduce and discuss them 1 at a time.*

In this lab, I operated a crane through a 30cm path three times, each time with a different maximum velocity. An overhead camera displayed the movement of the payload hanging below the trolley as the trolley moved along its path, and encoders recorded the movement of the trolley and the bridge. The payload moved along the trolley's axis as opposed to the axis of the bridge which is perpendicular to the trolley's axis. The recorded trolley deflections are represented in the following graphs for paths taken at maximum velocities of 30%, 60%, and 100% of maximum trolley speed.

The oscillations in Figure 1 show an amplitude of about 13mm while the trolley is moving from its starting point through the 30cm path. The larger oscillations that occur after 9 seconds are when the trolley is returning to its start position, so are not relevant. At 60% of maximum speed in Figure 2, the oscillations increase to 75mm, so a 100% speed increase resulted in a 477% rise in oscillations. At 100% speed in Figure 3, the oscillations improve slightly to a 65mm amplitude for the first peak, then the subsequent peaks are closer to 45mm amplitudes. This data demonstrates that faster motion has the potential to create more residual vibrations in the system, but after a certain maximum velocity, the vibrations can be reduced. The amount of vibrations generated are a function of both the move distance and the maximum velocity, so by holding the move distance constant at 30cm, this lab focused on how maximum velocity alone affects the system.

You should be discussing residual vibration and NOT the transient

Figure captions (titles) go only at the bottom

add a label to make it clear where the residual starts → *residual*

Do not show, or discuss irrelevant procedures and data

Trolley Deflection (30%)

- Trolley Deflection (mm)

Deflection (mm) axis: 30, 20, 10, 0, -10, -20, -30, -40
Time (s) axis: 0, 5, 10, 15

don't use colored backgrounds – it makes it harder to see the data

Figure 1: Deflection at 30% Speed

— you where also required to plot and discuss the encoder time history