**Tracking Control Lab**

We will use a simple tracking task to investigate the different aspects of closed-loop tracking. At the beginning of each round of testing, you will be able to set testing parameters. When a 20 s round is complete, you will have a chance to edit these parameters to try a different mode of control. At the end of each round, results and parameters will be printed out. **THE MAIN RESULT WE WILL LOOK AT IS MEAN DEVIATION.** All of the results are stored (one line per trial) in the file trackingdata.csv. You might not be able to open the file within excel at the same time you are collecting data. **ONCE YOU START EACH TRIAL, YOU WILL TRACK 'UNRECORDED' UNTIL YOU HIT THE MOUSE BUTTON AND RECORDING STARTS.** Once you begin, a timer will count down until the end of a trial. At any time during a trial, if you hit the mouse button the trial will end and it will give you your up-to-date stats.

**Assignment**

Write a basic introduction to the lab, including basic method section.

For each condition below, describe a hypothesis, report your results, and answer the answer the questions listed.

**1. Effects of practice.** Using default settings and control type 0 (Direct control). Do three rounds with minimal warm-up before you start each round. Did you produce values that were fairly close? Did you improve? Why or why not?

**2. Control method.**  There are three 'orders' of control. The 0-order control is direct, familial to you in terms of mouse control. In First-order control, your input impacts the change in location rather than location itself (velocity). In second-order control, input impacts the change in velocity (acceleration) rather than velocity itself. After warmup with each control, conduct a round of testing with 1st and 2nd order control. Compare deviations to part 1.

* Describe example control systems that use each type of control.
* What are some reasons why different control systems are used?

**3. Gain.** Gain describes the function linking the control input to the output delivered to the system. In some ways, it reflects how sensitive a control movement is to the system. Using control order 1, test at least three different gain settings and record your results. Try at least one setting (either very small or very large) that produces a breakdown in your ability to control the target.

* How does gain impact performance
* What might be consequences of having a gain that is too small? To large?
* Describe an example system you have used with inappropriate gain settings.

**4. Input Noise.**  Input and display systems will often have noise in them. For example, GPS coordinates are somewhat inaccurate; a speedometer might be 'wobbly'; and so on. This is different from the rate of information sampling, and it differs from whether your inputs are calibrated. Test 3 levels of noise (including 0 and two higher levels) under at least two control modes (0 and 1).

* Compare how similar levels of noise impacts these two control modes.
* Describe an example system that might have similar noise impacting control.

**5. Sampling rate.** A maxim of control theory is that to deal with noise, you need frequent sampling. If you have infrequent sampling, the tracking target can change and you won't know it. Run three rounds of testing under different sampling rate settings, using control mode 0.

* How does sampling rate impact performance? Why?
* Describe why distractions serve as limiting sampling rate during driving.

**6. Delay.** Sometimes, the result of an input does not have an immediate effect, and it takes some time to catch up. This could be because of internal dynamics of the system (internet lag in skype call), or part of the physical system (rudder control on a ship; driving on ice). Test control mode 0 and 1 under 3 different delay conditions.

* How did performance change?
* Qualitatively describe how/whether you changed your strategies to respond to delays.

**7. Operator-induced oscillation.** Under delayed feedback conditions, many times you can get repeated over-correction, which induces what is known as 'operator-induced oscillation (OIO)'. This is a feedback phenomenon similar to many physical 'closed-loop' feedback effects (like feedback in a microphone/PA system). Try to create conditions of driver-induced oscillation by playing with the gain, delay, and sampling rate parameters. After you create this, see what it takes to reduce/avoid OIO.

* What conditions did you find helped induce OIO (not just parameter values; describe qualitatively)
* What strategies might you use to break out of OIO when driving on an icy road?