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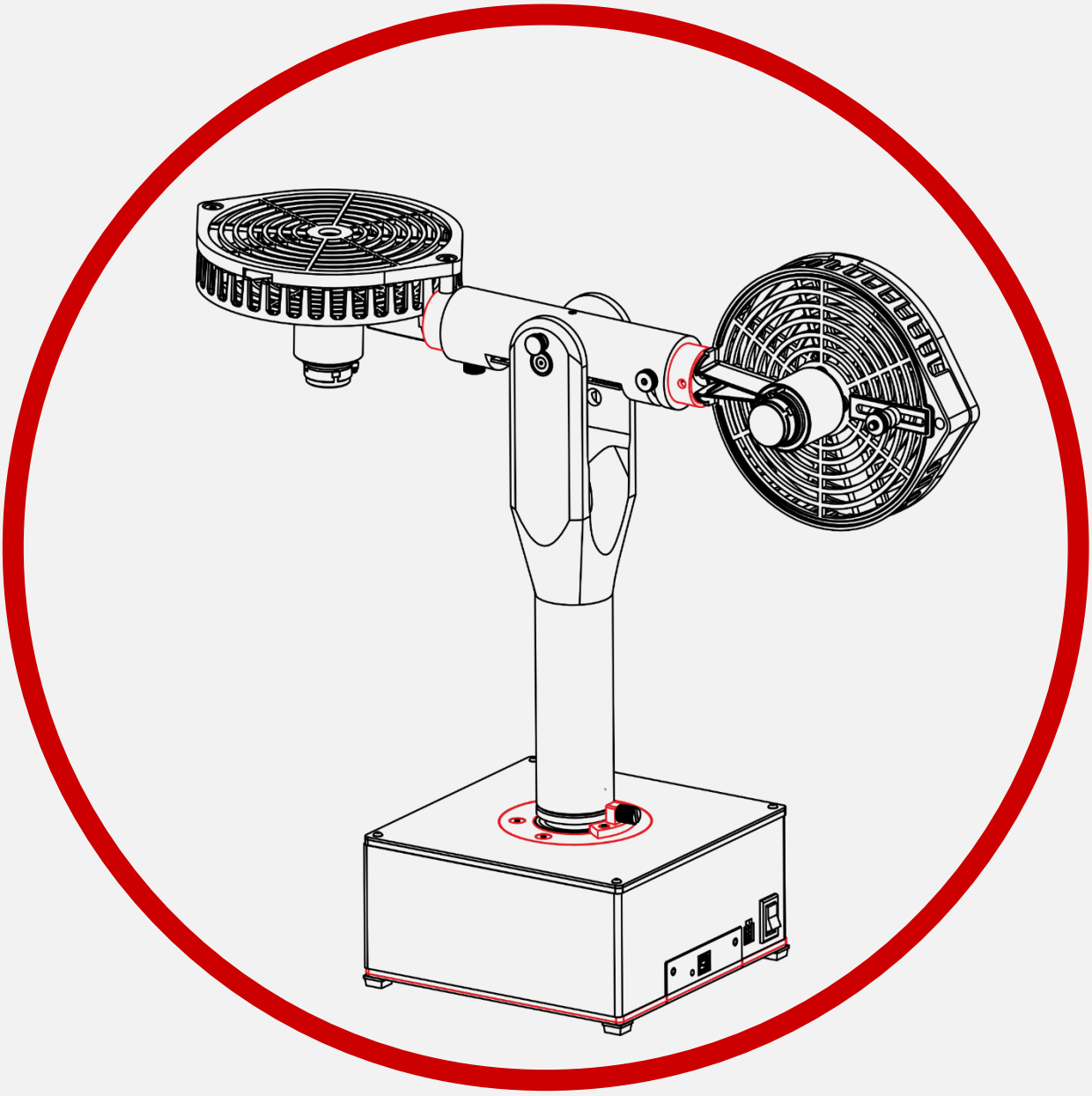

Aero 2

Qualitative PID Control

V1.0 – 14th February 2025

Aero 2 – Application Guide

Qualitative PID Control

Why Explore Qualitative PID Control?

In most systems, there are two types of control methodologies – open-loop control and closed-loop control. In the former, the control effort is proportional to the output variable. However, to automate this system, feedback from the system can be used to modulate the control effort and bring the output variable to a setpoint or the desired value. Although there are many closed-loop control strategies such as PID, LQR, lead-lag compensation, etc., the control method involves some tuning to achieve the required specifications.

One way to tune the gains involves manual tuning to achieve the required specifications in the system response. Such qualitative tuning, although simpler, requires expertise and knowledge regarding the control strategy. This lab tries to shed some light on manually tuning a PID controller based on the quality of the system response.

Please read the following concept reviews before this lab for relevant information.

- Modeling (sections 2b)
- Introduction to Control
- PID Control
- Longitudinal Speed Control

Qualitative PID Tuning

A standard methodology in tuning the system gains manually consists of the following steps:

1. Set the derivative and integral gains to 0, and gradually increase the proportional gain until sustained oscillations are observed.
2. Increase the derivative gain gradually until the oscillations disappear and the system is critically damped. Any further damping should increase the rise time.
3. Increase the integral gain until the steady-state error falls within the desired error threshold.

This process is often iterative, especially when an integral term is used. The proportional and derivative gains may have to be tuned to compensate for the addition of the integral term. Retuning may also be required if the sampling rate changes, or the nature of disturbance in the system changes (for example, the damping in the joints).