Process control laboratory practice
Cascade control

INTRODUCTION

Applying cascade loops is one possibility for improving control. Cascade control can be used if there is a well separable part of the controlled process in which the effect some disturbance is quick change in a measurable variable. Using this variable as controlled variable, an inner control loop is built up to compensate this disturbance. As a result, this disturbance will not reach the other parts of the process, or at least its effect will be quenched. Other disturbances are compensated according to the controller built on the original controlled variable.

The block scheme of this system is shown below.

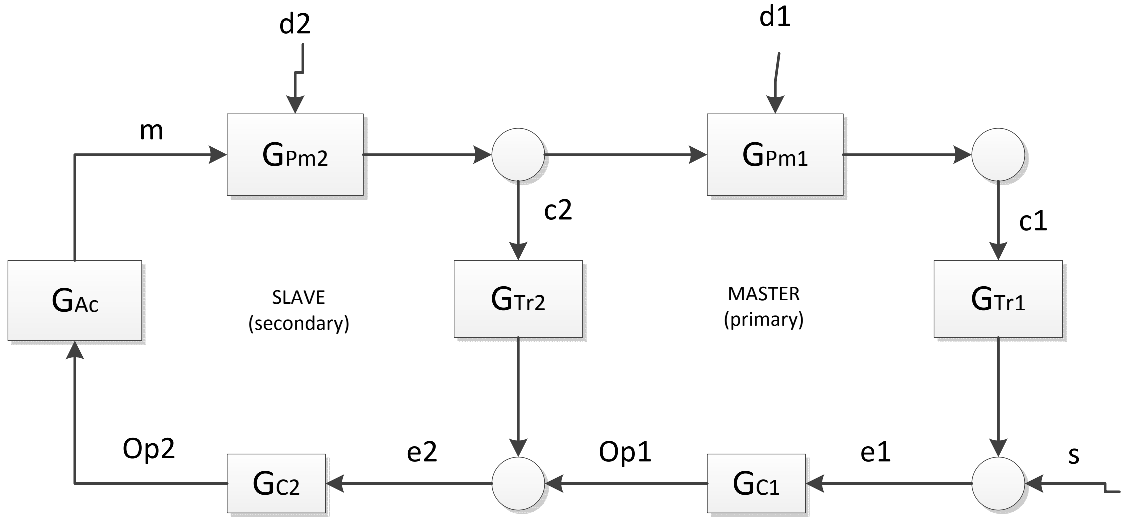

Figure.1. Block scheme of cascade control

The controlled process is broken down to two parts. The slave loop is denoted by index 2 (secondary loop). This internal loop can be considered as an element of the master (outer, primary) loop.

Cascade control works well if the cycle period of the slave loop is much shorter than that of the master loop. For this aim P controller is applied there, if possible.

Tuning

The inner (slave) loop is tuned first. For this aim, the outer loop is cut. The inner loop is tuned with the cycling method. Then close the outer loop and tune it in the same way.

Aim of the practice

Demonstrate how cascade improves control. First tune a simple loop (without cascade) with P, PI, and PID controller, and qualify it with control time, overshoot, steady offset, and integrated square error (ISE) independently for disturbances d1 and d2. Then do the same with well tuned cascade control.

Applied network models

Simple loop

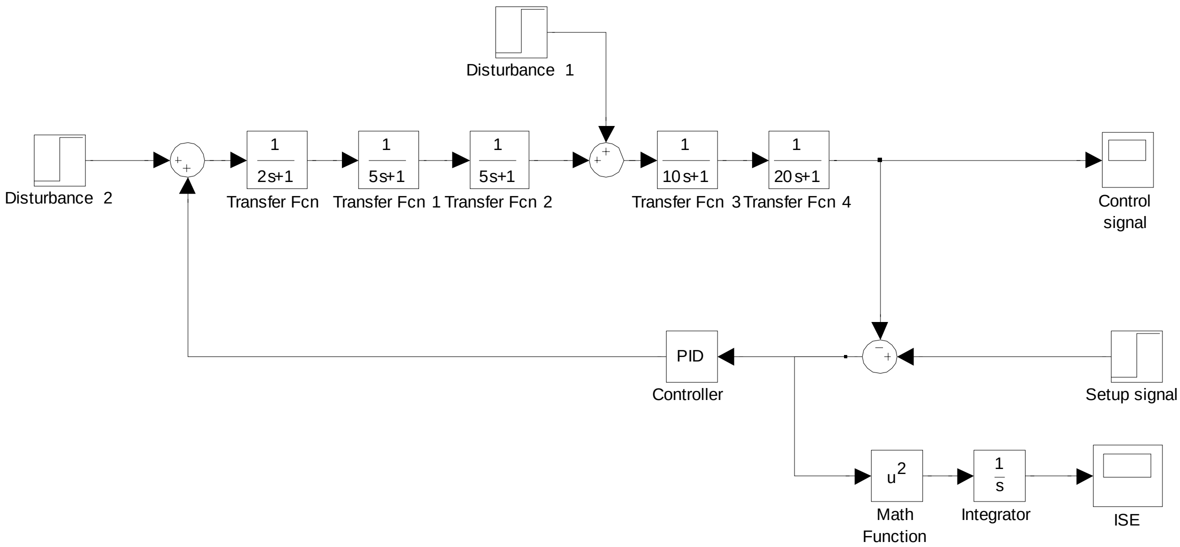

Figure 2. Simple loop

Cascade loop

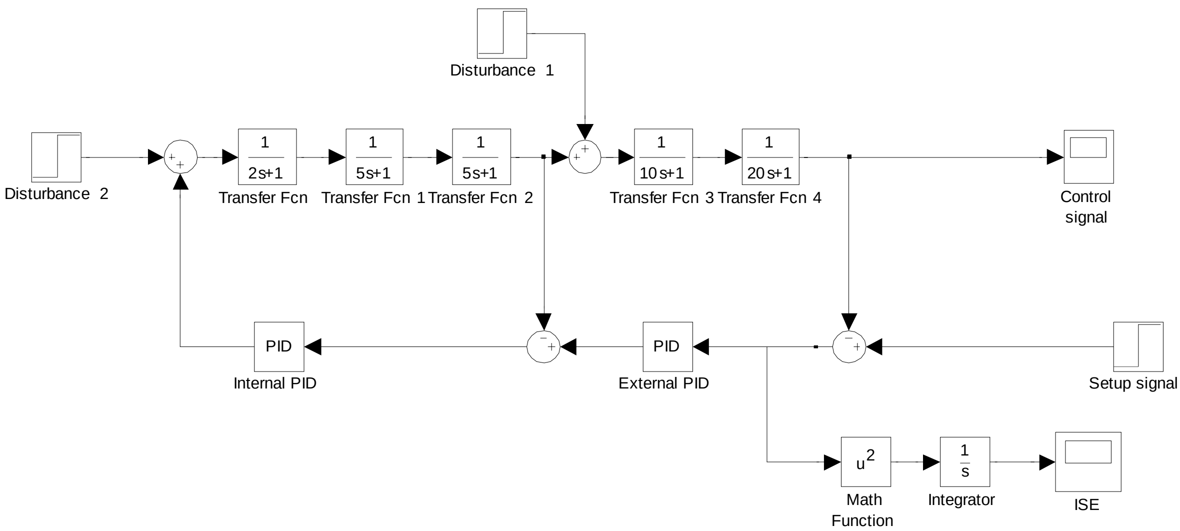

Figure 3. Cascade system

Names	Cascade control	Date

Analysis of simple loop

A_{Pcrit}=……… T_{crit}=………

	Controllers' parameters				
Controller	A_P	T_I	A_I	T_D	A_D
P					
PI					
PID					

	P		PI		PID	
Disturbance:	d_1=1; d_2=0	d_1=0; d_2=1	d_1=1; d_2=0	d_1=0; d_2=1	d_1=1; d_2=0	d_1=0; d_2=1
ISE						
steady offset						
overshoot						
control time						

Analysis of the cascade system

<u>Tuning the inner loop</u>

A_{Pcrit}=……… T_{crit}=………

A_P=………

<u>Tuning the outer loop</u>

A_{Pcrit}=……… T_{crit}=………

	Controllers' parameters				
Controller	A_P	T_I	A_I	T_D	A_D
P					
PI					
PID					

	P		PI		PID	
Disturbance:	d_1=1; d_2=0	d_1=0; d_2=1	d_1=1; d_2=0	d_1=0; d_2=1	d_1=1; d_2=0	d_1=0; d_2=1
ISE						
steady offset						
overshoot						
control time						

Evaluation

1. Is there some effect of the place of the disturbance to the quality of control in the simple loop and in the cascade system?
2. Which scheme seems better?
3. Is the criterion on the critical cycle periods satisfied?