

ANALYSIS OF PID CONTROLLER TUNING FOR LEVEL PROCESS

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Abstract:

To design a model for “multiloop tank control using LabVIEW”. An advance process reaction curve method to PID auto tuning is presented and validated on a multi-tank system with non-minimum phase dynamics. In this multi-tank system is obtained by controlling the motor frequency to maintain the running tank level condition. The relation of the flowrate and input frequency is measured, then the plant transfer function is generated by process reaction curve method. The experimental theoretical results are obtained by MATLAB and converted into dot M script file to support LabVIEW software and give the instructions to the DAQ system to control the multiloop tank systems. Then we implement the controller hardware to control and monitor the trainer without interfacing the computer.

Keywords —method by process reaction curve, Cohen coon, genetic algorithm,

INTRODUCTION

A multi tank level control system has two input and two output interacting system. In this system, we have considered three tanks each having equal cross section area and each tank can be assumed as a first order system which are connected in interacting mode.

The control system is intended to maintain the different level of the different

tanks at some predefined value respective of changes of input flowrate of motor pump.. Conventional PID controller is a powerful controller used in process industries to measure, regulate and control process variables. In this work, we also consider the effect of the disturbance (noise and bubbles) on the response of the system. According to these disturbances, we need to implement feedback forward controller with better tuning algorithm with genetic algorithm.

Thus, we implement transfer function of above multi tank level control system.

Level control in the tank and flow in between them there is a basic problem in process control industries almost all the chemical industries. So we used VFD (variable frequency drive) to control all tanks by changing the valve positioning. In this, all the tanks have their own manipulated variable to control liquid level inside the tank by the response of DPT (differential pressure transmitter) with closed loop of the system. These tanks which are connected and interacting are observed by applying step input and step response, these systems are improved by designing various types of controllers like feedback controller and feed-forward controller. Then the system is controlled by the hardware PID controller depends on the performance of tuning methods.

LITERATURE SURVEY:

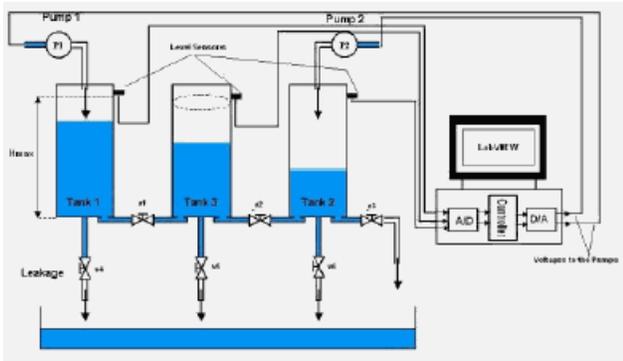
Control of liquid level in the running tank in any process control is a challenging task. There are many different connections of tanks possible in the plant like interacting and non-interacting. Many types of disturbances affect the performance of the system.

Designing of PID controller to increase the efficiency of process outputs. Frequency is varied to control the motor pump and also increases the

efficiency of the flow rate. So this type of multivariable controller is used to increase the accuracy in process control industries.

PROCESS OF WORKING:

This apparatus consists of three interconnected tanks. Each tank is fitted with a static pressure sensor, which gives a voltage output proportional to the level of liquid in the tank. There are six manual hand valves $v_1, v_2, v_3, v_4, v_5, v_6$ respectively, which can be utilized to vary the configuration of the process. In this six valves, three valves are used for drain control, three valves are used to control various levels of the tank. Two diaphragm pumps are utilized in this apparatus. These pumps are designed to give an accurate well-defined flow per rotation. The flow rate provided by each pump is proportional to the voltage applied to vary the frequency by VFD (variable frequency drive). Liquid is pumped into the tanks. The apparatus is interfaced to a computer using the National Instruments, DAQ data acquisition card. The function of the board and processing of sampled data is carried out in the LabVIEW programming multivariable controller for multi-level tank system.



speed positive displacement pumps with variable frequency drive for controlling the flow rate, five transparent process tanks fitted with level transmitters.

The process signals from level transmitters are connected to Multifunction I/O & NI-DAQMX which is connected to computer through USB port communication. The process parameters are controlled through software and the output is fed to variable frequency drives used for the pumps. This process is used to control the whole system with closedloop control. It is the process of working for multivariable trainer kit.

MULTIVARIABLE TRAINER KIT:



Multivariable control trainer is designed for teaching the basic level control principles for control engineering. It is a combination of five tank systems, usually also known as Quadruple Tank system. The setup consists of supply water tank with two variable

PROCESS REACTION CURVE METHOD;

The process reaction curve is an approximate model of the process, assuming the process behaves as a first order plus dead times system. The process reaction curve is identified by doing an open loop step test of the process and identifying process.

Model parameters.

- Put the controller in manual mode
- Wait until the process value (Y) is stable and not changing step the output of the PID controller - The step must be big enough to see a significant change in the process value. A rule of thumb is the signal to noise

Ratio should be greater than 5.

- Collect data and plot as shown below.

Ki=11.91

· Repeat making the step in the opposite direction.

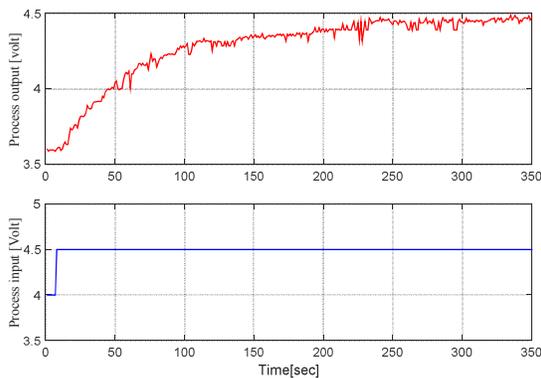
Kd=116.6

· $K = \frac{\text{change in the process gain}}{\text{Change in manipulated variable}}$

Change in manipulated variable

PROCESS GRAPH WITH PID TUNNING:

Process in which one or more parameters of device or model are adjusted upwards or downwards to achieve an improved or specified result.



Matlab coding:

```
tic
clc
clear all
num=[0.7 0];
den=[65 1];
sysrl=tf(num,den,'InputDelay',5);

options=gaoptimset('PopulationSize',60,'PopInitRange',[0 0 0;150 150 150]);

[x,val,reason,output,population,scores]=g
a(@pid_objfun_ISE,3,options)

num_pid=[116.6 57.7 11.91];
den_pid=[1 0];
rl_pid=tf(num_pid,den_pid);
sys_rl_open=series(rl_pid,sysrl);
sys_rl=feedback(sys_rl_open,1);
ga_pidtf=tf([x(1) x(2) x(3)],[1 0]);
ga_sys=feedback(series(ga_pidtf,sysrl),1);
time=0:0.1:30;
[yg t]=step(ga_sys,time);
[yrl t]=step(sys_rl,time);
plot(t,yg,'g*--')
plot(t,yrl,'r+--')
toc
```

TRANSFER FUNCTION:

$$G_m(s) = \frac{0.7}{65s+1} \cdot e^{-5s}$$

Cohen Coon Tuning:

Kp=57.7015

Zeiger nichols Tunning:

Kp=10

Ki=2.5

$K_d=15.6$

Matlab coding:

```

num=[0.7 0];
den=[65 1];
sysrl=tf(num,den,'InputDelay',5);
options=gaoptimset('PopulationSize',60,'PopInitRange',[0 0 0;50 50 50]);
[x,val,reason,output,population,scores]=ga(@pid_objfun_ISE,3,options)
num_pid=[15.6 10 2.5];
den_pid=[1 0];
rl_pid=tf(num_pid,den_pid);
sys_rl_open=series(rl_pid,sysrl);
sys_rl=feedback(sys_rl_open,1);
ga_pidtf=tf([x(1) x(2) x(3)],[1 0]);
ga_sys=feedback(series(ga_pidtf,sysrl),1);
figure(1)
hold on;
time=0:0.1:30;
[yg t]=step(ga_sys,time);
[yrl t]=step(sys_rl,time);
plot(t,yg,'g*--',t,yrl,'r+-')
toc
    
```

Genetic algorithm:

Transfer

Function= $0.7/65s+1 e^{-5s}$

Matlab Coding :

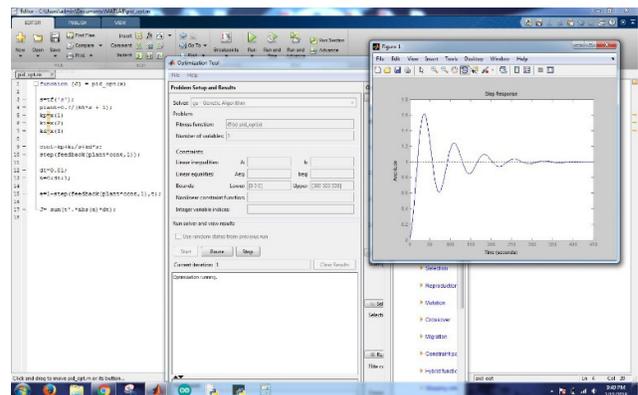
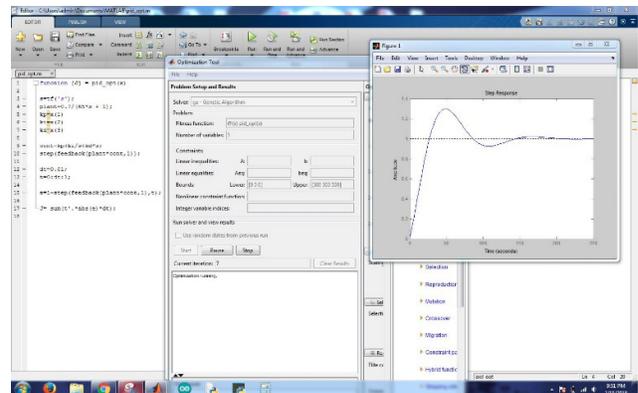
```

function [J] = pid_opt(x)
s=tf('s');
    
```

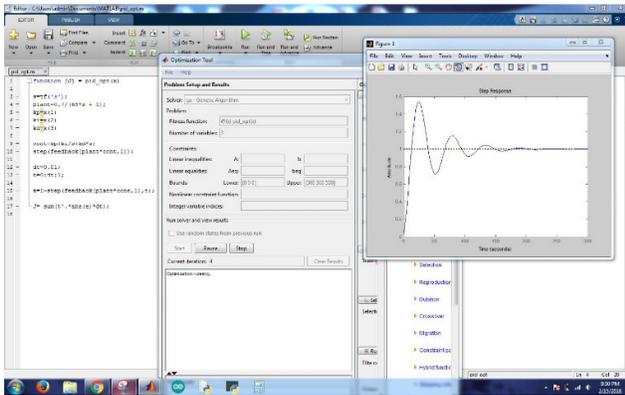
```

plant=0.7/(65*s+10) e^-5s;
kp=x(1)
ki=x(2)
kd=x(3)
cont=kp+ki/s+kd*s;
step(feedback(plant*cont,1));
dt=0.01;
t=0:dt:1;
e=1-step(feedback(plant*cont,1),t);
J= sum(t'.*abs(e)*dt);
    
```

Response:



FINAL RESPONSE:



Response for various types of connections of the multi tank system which is connected in Interacting mode. Then the response is analyzed by designing various types of controller like feedback, feed forward and combination of feed and feed forward.

In interacting three tank system, first we calculate the relative gain array and finally response is observed by designing a PID controller with step input.

For Interacting system, first we observe the response without applying the disturbance to the system and then we are applying the disturbance to the second tank.

By applying the disturbance to the system peak overshoot of the system increased. To reduce the effect of these disturbances we are designing the feed forward controller. By using combination of feedback and feed forward- feedback controller, peak overshoot of the system is minimized.

Finally the system control under closed loop by the hardware PID controller. The good response algorithm is dumped in the PID controller, then the process controlled automatically. Just give the instruction to the PID controller the response is taken automatically by the process

LINKS AND BOOKMARKS:

- <http://ethesis.nitrkl.ac.in/5781/1/212EC3161-1.pdf>
- <http://educyclopedia.karadimov.info/library/pidtube2.pdf#page=1&zoom=auto,-99.798>
- <https://www.researchgate.net/file.PostFileLoader.html?id=57c4adfb217e20b30076a061&assetKe=AS%3A400539159416834%401472507385889>
- <http://www.ijaiem.org/Volume4Issue1/IJAIEM-2015-01-21-37.pdf>
- <https://www.youtube.com/watch?v=KErYuh4VDtI>

CONCLUSIONS:

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