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Design of PID Control Experiments on the Internet

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Abstract

Technology always advance with time, there is a new way to learning. We will use the Internet to control the remote experiment equipments. In this essay we will design a personal learning environment; we will not only learn by the web pages but also use the Internet to make some experiments that we should make it in the laboratory. By this way students could observe the simulate situation and make some development experiments

In this essay we will use LRS [1] in remote computer, and will use PID control mode to operate equipment in laboratory. We can monitor the experiment equipment by camera. We could understand the experiment result and effect.

This system gets a lot of good reply in education. I believe this technique can also use in industrial remote controller.

1. Introduction

In nowadays, students can use the Internet to observe the equipment's operations [2][3], or use ActiveX, Java Applet to develop the user's control program. But it is limited in single-side controlled, if we use the remote control equipment that applied by school or manufacturer. In this essay we will use LRS [1] remote control system to provide an experimental environment which students can design personal control mode, for example, PID control, phase-lead control, phase-lag control, adaptive control, robust control of DC Servo motor. By this way we may control the remote laboratory equipments.

The benefit of using the Internet to control experiment equipments is to let learner can feel the remote practical training as same as the experiment in traditional laboratory. When the users utilize LRS to login account and password and verify successfully, they can control the DC Servo motor equipment. Furthermore, students utilize the software VisSim [4] to design control mode. This essay makes a description of PID control experiment as a result that students choose different PID control arguments to control the DC Servo motor, and understand the different PID control arguments cause the property in experiment. Those experiments will be taken photos by a video camera and seen the experiment results by Internet in the distance. The learner will take participate in the experiments more constructive.

2. System Overview and Design

As figure 1, this is the picture of using the system overview. The left side of the system overview is the controller server. It connects and controls the DC Servo motor experimental equipment which has the function of feedback control. We use VisSim software to design and plan the control mode. By using the interface card we can make a closed-loop position and speed control. The right side is the client end. It can monitor or control the equipments.

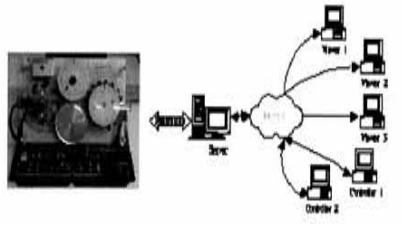

Figure 1. System overview of the designed control experiments

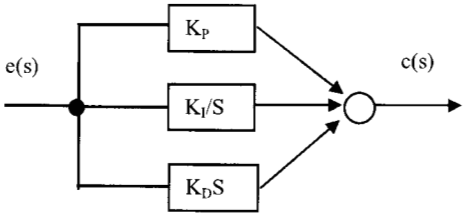

Figure 2. PID controller diagram

The computer in the left side has installed the LRS system which the text used, and it supplies the users to inquire, make an appointment about experimental time and take down the students' learning states. Even students are not in the laboratory they still can have experiments in a comfortable, convenient, and under a pressure less situation.

The ordinary controller system design steps are following:

(1) Systematic model construction: A same property in physics model instead of practical system.
(2) Description about mathematical model: Using the physical law to induce the description about the system of mathematical model.
(3) Analysis: Proceeding the quantitative analysis in system response and qualitative analysis in systematic stability to system.
(4) Design the controller: According to the data about the analysis, it can design the appropriate controller to let the system reach the anticipant demand.
(5) Test: A practical test to evaluate the systematic performance.

To achieve the aim that we have been anticipant, we will use the technique of remote control to adjust the PID controller*s* parameter. We will rely on observing the system response wave to understand how the K_p, K_i, K_d parameter affect the system,

There are many kinds of DC Servo motor control modes [5]. In this essay we will use the most normal PID control to be the example and discuss it. As figure 2 is PID controller diagram.

(1) Proportional controller: C(s)=Kp. When Kp rate get higher, the response would be more fast, and the steady-state error will be lower. But the overshoot and the stable time will increase. If we want to delete the steady-state error, we need to unlimited gain, but this way may cause the system unstable.
(2) Integral controller: $C(s) = \frac{K_i}{s}$ can correct the steady-state error, but add the integral controller may let the root locus departure to right and cause the system unstable. This way will lower the system stability.
(3) Derivative controller: $C(s)=K_dS$ does not have any benefit to the steady-state error, but adding it can let the root locus move to left and tend to stability.
(4) PI controller: $C(s)=K_p+\frac{K_i}{s}$ does not have any error in the transient response and the steady-state error would

be better if we change the pole point position.

(5) PD controller: $C(s)=K_p+K_dS$ causes system overshoot and the response of setting time can be better. But the improvement to the precision of steady-state is limited.

(6) PID controller: $C(s)= K_p + \frac{K_i}{s} + K_dS$ can make the steady-state error be better and the transient state can also change the parameter K_p, K_i, K_d to get a better response.

Altogether, use the PI controller can improve the steady-state error and the PD controller can better the transient response but the PID controller can satisfied all the requisition.

3. Implementation and Results

When students log in Tung Nan Institute of Technology learning web http://e-learn.tnit.edu.tw/, they can learn all the correlative knowledge and the situation of interactive course as figure 3 and 4.

Figure 3. Learning web site

Figure 4. Learning material

The hardware of this experiment is like figure 5. It includes the DC Servo motor which connects to the server and video monitoring system.

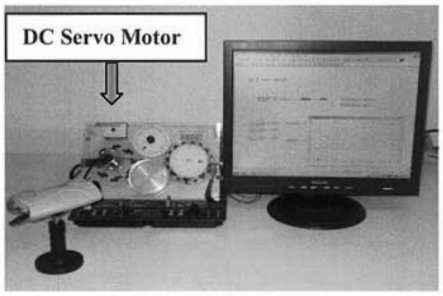

Figure 5. The control experiment hardware in the server end

When students want to practice outside the school they just have to key in this IP address http://140.129.122.1 then they could enter the remote Servo motor experiments. Figure 6 shows the management course center picture. The figure 7 shows the record of student appointment. When students use the remote control system to do experiments on Internet, they can adjust the PID controller value, the result shows on figure 8 to 13.

Figure 6. LRS Interface diagram

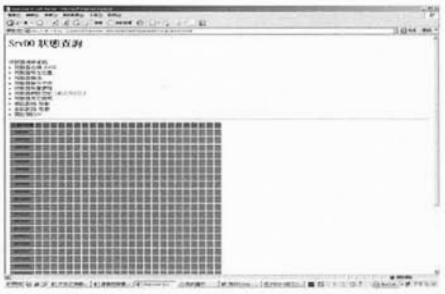

Figure 7. The appointment diagram

When Kp value is lower, the response would be slower, and it needs more time to achieve the aim but the oscillation is lower like figure 8

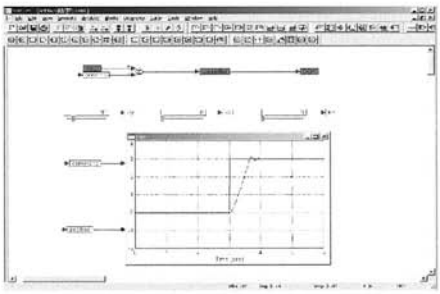

Figure 8. The PID control experiment K_P=10

When Kp value get higher, the response would be fast, and the achieve time will be shorter but the oscillation would higher, as figure 9

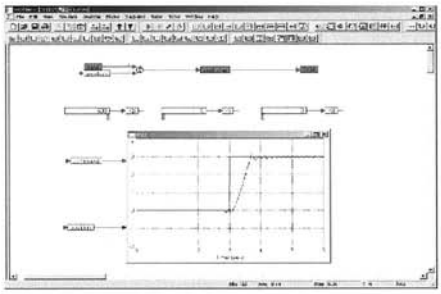

Figure 9. The PID control experiment K_P=90

According to the Ziegler- Nichols theory we can get the optimal value and the oscillation won't be too big.

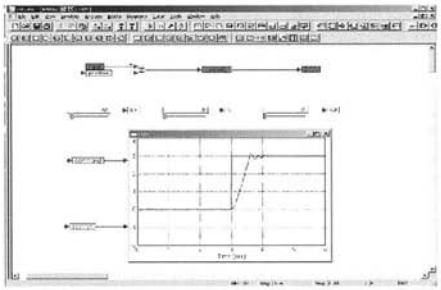

Figure 10. The PID control experiment K_P=48

When we fix the Kp value then adjust Kd value, the oscillation can be improve but it still have the steady-state error, as figure 11.

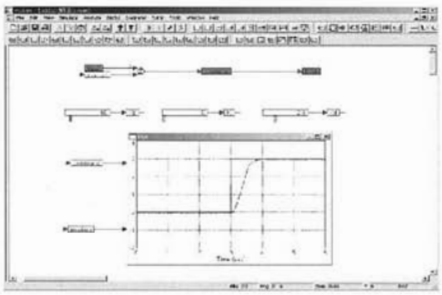

Figure 11. The PID control experiment
K_P=48 K_d=2.3

After fixing K_P , the steady-state error will disappear by adjusting K_i but the oscillation still appears as figure 12

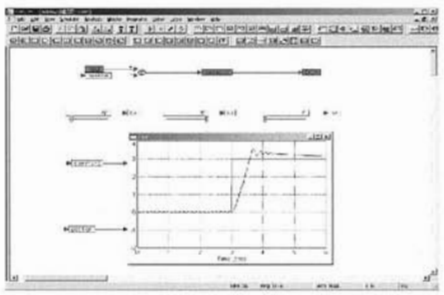

Figure 12. The PID control experiment
K_P=48 K_i=0.05

Finally, we adjust K_p, K_i, K_d to improve the steady-state error. Not only system overshoot but the setting time will decrease and improve transient response as picture 13.

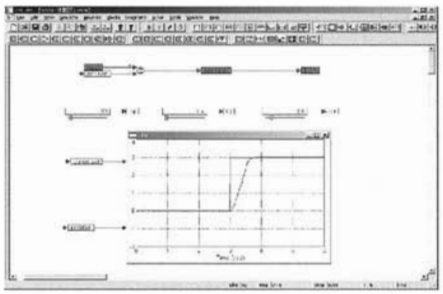

Figure 13. The PID control experiment
K_P=48 K_i=0.05 K_d=2.3

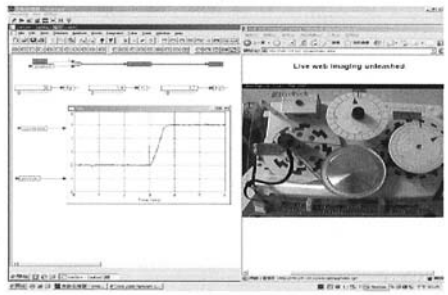

Figure14. The experiment process using LRS system

Figure 14 is to use LRS system to operate VisSim software program in remote. We can see the experiment effect as figure 14 as same as experiment effect in local end, and it is thus evident that use the remote control will be a feasible learning way.

4. Conclusions

In general, when one proceeds to study or instruct of experiment, he is always limited to execute owing to experimental equipment in school lab. The outcome often results in the waste of time and even affects the efficient of progress about experiment and teaching. However we can make use of Internet to proceed remote control, people who do not have VisSim software and hardware DC Servo motor will proceed the experiments at home easily.

Besides adding the remote video monitoring system, we can not only peruse the data about experiment even but observe the situation about the operation of experiment equipments.

5. Acknowledgements

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6. References

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