Design of Control Experiments on the Internet

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Abstract

We describe the design of control experiments on the Internet. In this control experiment laboratory, users perform common A/D, D/A, and I/O controls in traditional automatic controls course. Furthermore, the networked control course experiments can also be established. Users choose different control parameters in a PID controller to control a remote DC motor. The outputs of these experiments are displayed in the user end by plots or by real-time video. The remote experiments described in this paper can be of benefits to users to be familiar with fundamental controls and networked controls in distance learning.

1. Introduction

Distance learning on the Internet is getting popular [1]. We have witnessed many universities and content providers are using this infrastructure to deliver their contents and perform learning [2, 3, 4]. Meanwhile, web-based learning platforms and authoring tools are available [4, 5]. In this paper, based on what we have achieved in the design of networked visual monitoring systems [6], we design control experiments on the Internet. Learners are allowed to perform control experiments at the remote ends.

Networked control and distance learning control courses are available on line [7, 8]. This approach can be of benefit to learner on the remote site as well as in the traditional classroom. To enhance the results in the above, our designed control experiment is shown in Figure 1. The client ends are able to control remote devices, e.g., DC motor, that connected to a server on the Internet. In order to make use of the existing tools that provided by commercial control simulation software, we integrate our design with VisSim [9] or MATLAB [10]. Users can perform common A/D, D/A, and I/O controls. Furthermore, users choose different control parameters in a PID controller to control a remote motor. The outputs of these experiments are displayed at the user end by plots

or by real-time video. The system can record the whole experiment process. Under such a scenario, learners actively participate the experiments.

The rest of the present paper is organized as follows. In section 2, we first present the system overview and design. The main system architecture is described. Detail implementations are given in Section 3. Some experiment results are also presented. In section 4, we conclude our work.
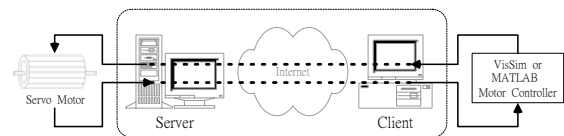

Figure 1. Control experiments on the Internet.

2. System Overview and Design

The system overview is shown in Figure. 2. The design experimental platform includes the client end and the server end. Many clients can access the server simultaneously. At the server end, it has I/O ports. We have special consideration of the access priority. Thus, different user may have different access level, which represents the devices can be controlled by different priority users. In this manner, the security of the platform is enhanced. The client ends can control and view the results at the remote end on the Internet. Each server is equipped with video cameras to capture the video signals and a control interface card to perform the A/D, D/A, and I/O signal captures.

The detail signal flows are shown in Figure 3. At the server end, visual input signals is captured and compressed before transmission on the Internet. We make use of video compression standard H.263 format in this design. The control signals and data signals are packetized in TCP or RTP/UDP formats. The decision controller is allocated at the client end. Users may give their control commands step by step using the design input forms. System may perform the feedback control in automatic control mode.
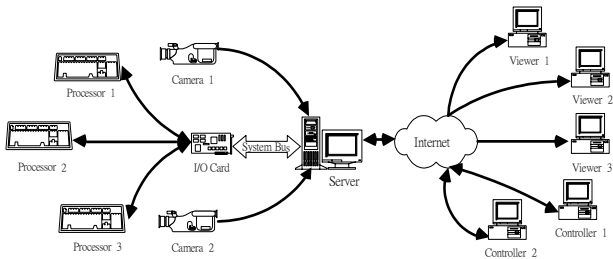
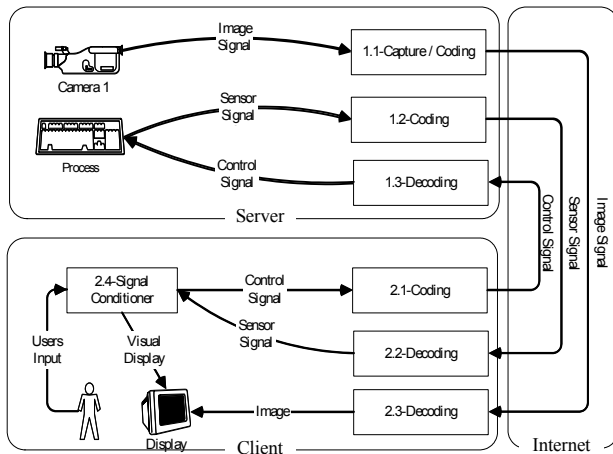**Figure 2. System overview of the designed control experiments.**

Figure 3. Signal flows in the designed control experiment.

3. Implementation and Results

The server end is shown in Figure 4. A DC motor is connected to a PC. The DC motor is controlled by a simulation software, such as VisSim by Visual Solution Inc. or Matlab by Mathworks, Inc. Indeed, both VisSim and MATLAB provide a convenient user interface for setting the controlled devices and the control laws. By following the architecture as described in Section 2. We design an interface, nRT-DAC3, between VisSim and MS Internet transmission protocol implementation by using the MS Visual C++ development tool and MS ActiveX technology. Then, the control inputs and outputs can be exchanged between the server end and the client end. And the signals are displayed in the simulation window, such as VisSim and MATLAB or MS Windows environment, see Figure 5 and Figure 6.
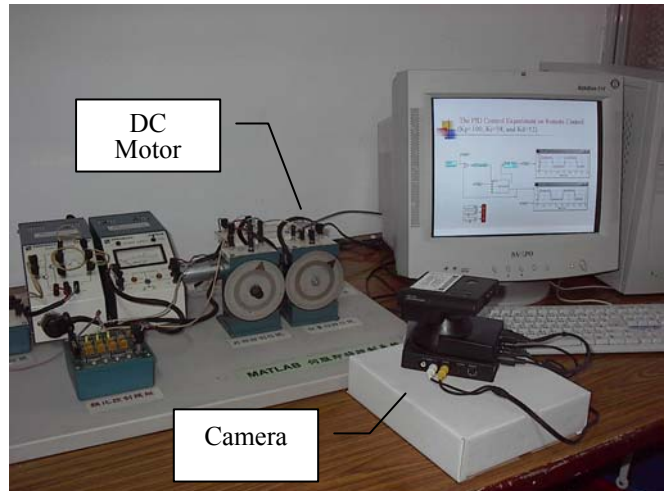

Figure 4. The control experiment hardware in the server end.

There are two kinds of data in the transmission network. One is the control signals and data and the other is the video signal. In the first case, the phenomena of jitter, delay, and packet loss are taken into account, especially for the networked feedback control systems. As shown in Fig. 5 and Fig. 6, we designed a PID control system. The controlled device is located at the remote end. The plots in each window include the position changes in the server end and the client end. Different PID control parameters result in different system responses. The original is shown in the right upper end of Figures 5 and 6. The controlled feedback signal is indicated in the right lower end of Figures 5 and 6. The delay between these two ends is about 3 ms in LANs.
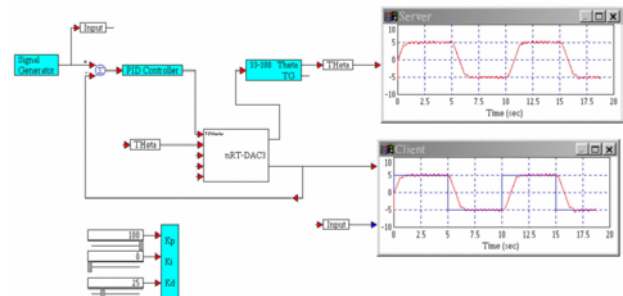
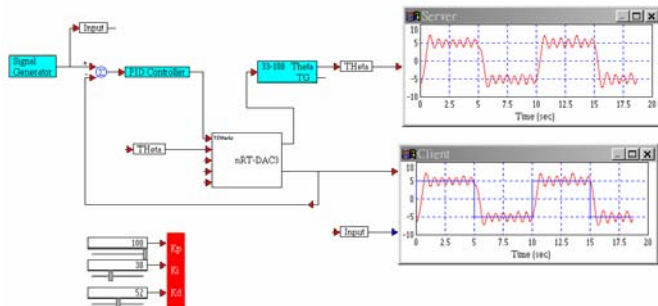**Figure 5. The PID control experiment Kp=100, Ki=0, and Kd=25**

Figure 6. The PID control experiment
Kp=100, Ki=38, and Kd=52

4. Conclusions

We describe a networked control experiment on the Internet. The system integrates a designed signal application interface and a commercial control simulation software, VisSim or MATLAB. We make use of MS Visual C++ and MS ActiveX technology in the above API. In this scenario, the standalone simulation software is extended to a distance learning environment. With the success of this stage, we are going to set the learning environment to a web-based approach. It is clear such a learning environment is of benefit to distance learners.

5. Acknowledgements

6. References

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