International Journal of Current Trends in Engineering & Technology
www.ijctet.org, ISSN: 2395-3152
Volume: 07, Issue: 06 (November -December, 2021)

Analytical Study of Smith Predictor and Correlated Control Systems Network

Arvind Pandey, Namrata Sant
Electrical department, BIT Bhopal

***Abstract** -The Networked Control System (NCS) uses a real-time communication network to control closed systems. The distributed control system phase involves distributing information between sensors, actuators, and controllers over the communication network. This research analyses network delays, packet loss, and their effects across the entire NCS communication channel. User Datagram Protocol (UDP) has been used to establish communication channels between the two computers in real-time, which is why network delays and packet loss are studied. Although UDP is unreliable due to the transfer of lost packets, it is still popular in implementing the control system because of the rate of data transfer faster into the UDP. The negative effect of network delays is reduced by using the classical Smith Predictor Compensator. The performance of Smith predictors and filters was studied to reduce network-initiated interference. In addition, a different combination of Smith Predictor, PI control, and Low Pass Filter (LPF) has been studied for its effects on network delays and packet loss. The test was performed on an upgraded DC Servo Moor network system and a P-I controller designed based on the Ziegler-Nicholas transmission that provides speed control for DC Servo Motor. The knowledge results were in good agreement with the effect of simulation.*

Keywords:- PID Controller, user datagram protocol, network control system, DC servo motor, Smith predictor.

1. INTRODUCTION

Networked Control System (NCS) are two types of problem areas encountered in a networked system: managing and controlling the network. Network control means the problem of network control data, e.g., network control system. Nowadays, the regulatory community aims to expand research such as integrating control, computer network, communications, and computer science. The response control system in which the control loop is closed by a real-time network is called the Networked Control System [1]. The plant, sensor, controller, actuator have difficulty finding the same location, so signals need to be transferred from one location to another. In modern industrial systems, these components are often connected to a network media that results in the so-called NCS. In basic NCS, the plant, controller, sensor, and actuator are not available in the same location in the industry, so the information needs to be transferred from one location to another. The Block diagram represents the basic network control system. When the body plant, sensor, and actuator are located in the same location, the controller is located elsewhere.

A network connection is required between the two locations to share information. NCS is a control system in which the control doors are closed through a real-time network called an NCS. The NCS feature is that the information packet (response signal or control signal) is exchanged via the network between the part of the system. NCS data transfers the sensor to the controller and the control signal from the controller to the actuator via the network. In NCS, the data communicates in the form of packets via the network. PID control is widely used in network control systems because it provides better performance than others.

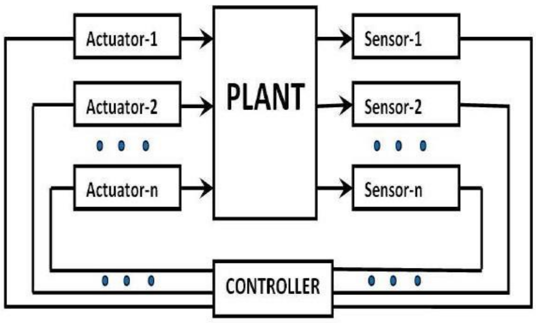

Figure 1 Point-to-Point Architecture of NCS

2. LITERATURE SURVEY

The Networked Control System (NCS) is a growing subject of research benefits in multidisciplinary engineering. NCS research primarily involves the network used and the construction of compensation delay and control. Instead, NCS co-design is also a topic of interest to many researchers [9, 10]. A loop system close to the NCS response loop form [7, 11,12, 13]. Networks are an integral part of the NCS, and many network protocols are used in the NCS [3]. Nowadays, a wireless network is used in the NCS [14]. The installation of this network introduces system delays. Delays slow down performance and reduce the system [12]. In addition to delays, other issues such as jitter [5] and packet loss are also present. Connect to both PCs with the help of UDP protocol. The two PCs are connected via a LAN to deliver packet loss and delays. Now system stability is a major problem in the construction and analysis of controls.

The two methods of control design are straightforward or indirect. Align with unintentional delays and indirectly think delays in the system. To use the design of the P-I controller to control the speed of the DC servo motor. DC servo motor model is taken from [15]. The main purpose of the P-I controller design is to adjust the parameters of the parameter properly. Ziegler-Nicholas introduced the PID controller tuning method in 1942. They propose the tuning method as a response and preservation method for oscillation [16, 17]. Not suitable for advanced order systems [18]. So that advanced tuning method such as analytic, predictor [19], and automatic tuning [20] has improved. Manning Tuning is too complex for automatic tuning transmission introduced by Astrom and Huggland.

3. PROBLEM STATEMENT

The main objectives of the thesis are

1. Upgrade a real-time network control system using a connection between two PCs using UDP in Simulink.
2. PI-Controller design of DC Servo motor and speed control of DC Servo motor setup test.
3. Design the Smith Predictor controller to compensate for time delays caused by network communication and forecasting.

4. PROPOSED METHOD

A proportional Integral Controller is good for increasing the response's speed and eliminating the steady-state error of the response. P-I Controller has two terms combination Proportional and the Integral term. P-I Controller developed because of the desirable property that system has type-1 transfer function for open-loop anal it is having zero steady-state error for a unit step input. In P-I Controller design, use the Ziegler-Nicholas PID tuning method, in which the Derivative term is zero. In the Ziegler-Nicholas closed-loop tuning method, the only proportional term is used, and all other terms are zero. In this method, controller gain increases until the process's output have sustained oscillation, as shown in figure 2.

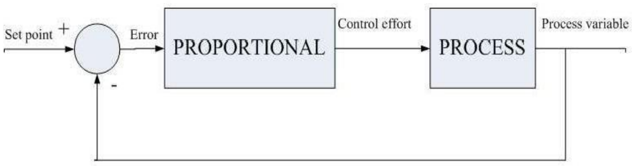

Figure 2 Ziegler-Nicholas closed-loop test

5. RESULT AND ANALYSIS

The main purpose of this chapter is to show how study and filtering are critical to understanding design limitations. The filter is built with the known win-doing techniques. In the window system, create the desired response of frequency H(F) in the frequency field and then find its frequency response (IFT). It is also the active response function of H(k), after which the H(k) pressure response function is removed, and the window is set to form hk in the time zone or domain location k. Both H(k) and H(F) are in the corresponding domain functions in the following discussion, where hk and hp are their separate forms. The reduction and whk implants represent the Finite Impulse Response (FIR) digital filter, hk. The Impulse Response Function H (F) domain has a primary domain but has been reduced to a suitable length for use in a digital domain. The reduced form is hk, Fast Fourier Transform (FFT), which is made so that the call can be seen in the frequency response hp in the frequency range.

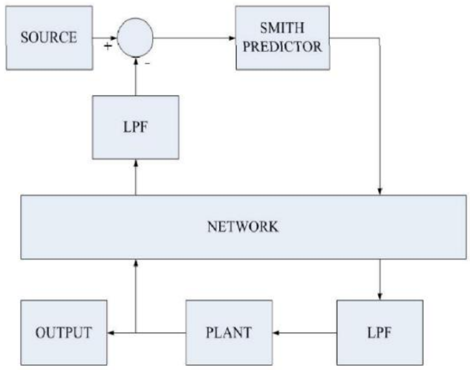

Figure 3 Networked Smith Predictor Filter

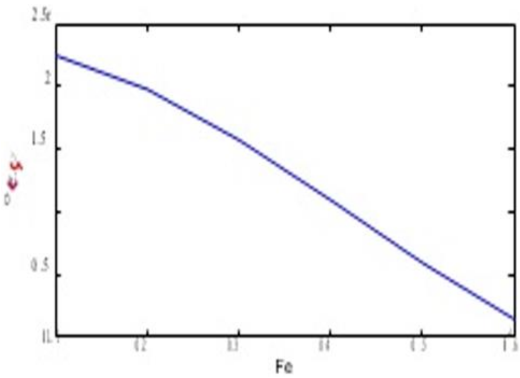

Figure 4 effect on delay with the use of LPF constant alpha

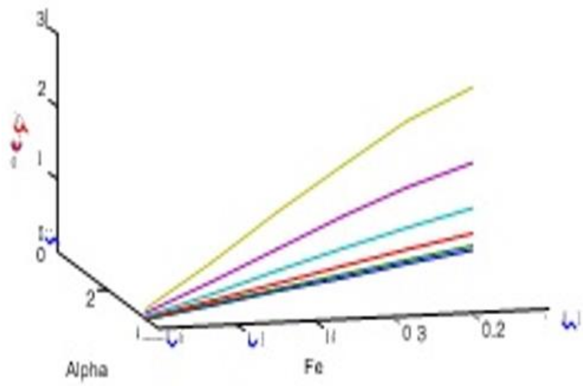

Figure 5 effect on delay with the use of LPF constant Fe

We compare the result of different combinations of filter and Smith Predictor or say that with Smith Predictor and filter, without Smith Predictor and filter.

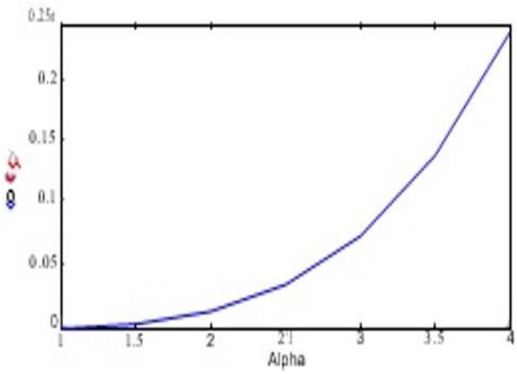

Figure 6 effect on delay with the use of LPF

6. CONCLUSION AND FUTURE SCOPE

The packet dropouts and delay in NCS occurs during data transmission from one network component to the other. A real-time networked servo platform for studying NCS characteristics is developed. It uses Mat lab software, PCI 6221 as DAQ card, as a connector cable between PC and PCI 6221 with the driver software. PID controller using Z-N tuning is performed and implemented in real- time for servo system speed control. Filtered Smith predictor used for delay compensation in the feedback loop and design predictor filter. The controller used here is not adaptive to match the stochastic behavior of network characteristics, an adaptive or predictive controller implementation may be the next work. The networked servo control system developed here is connected to a LAN. It may be extended to, Internet-based servo control system.

REFERENCES

[1].W. Zhang, M. S. Branicky, and S. M. Phillips, "Stability of networked control systems," Control System s, IEEE, vol. 21, no. 1, pp. 84-99, 2001.

[2].R. A. Gupta and M.-Y. Chow, "Networked control system: Overview and research trends," Industrial Electronics, IEEE Transactions on, vol. 57, no. 7, pp. 2527 - 2535, 2010.

[3].F.-L. Lian, J. R. Moyne, and D. M. Tilbury, "Performance evaluation of control networks: Ethernet, ControlNet, and DeviceNet," Control System s, IEEE, vol. 21, no. 1, pp. 66- 83, 2001.

[4].I. Kaya, "A new smith predictor and controller for control of processes with long-dead time," ISA transactions, vol. 42, no. 1, pp. 101- 110, 2003.

[5].Y. Jianyong, Y. Shimin, and W. Haiqing, "Survey on the performance analysis of networked control systems," in Systems, Man and Cybernetics, 2004 IEEE International Conference on, vol. 6. IEEE, 2004, pp. 5068-5073.