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AN IMPLEMENTATION OF COMPENSATION SCHEME OF TIME DELAY WITH NETWORK CONTROLLED SYSTEM APPLICATION

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ABSTRACT
Feedback control systems wherein the control loops are closed through a real time network are called networked control system (NCSs). Network control systems (NCSs) are spatially distributed systems in which the communication between sensors, actuators, and controllers occurs through a shared band limited digital communication network. Time delay occurs used for networked control system when the exchange of data among sensors, actuators and controllers connected through the shared medium. Such delays affect the system Performance degradation and the reduced stability or total instability of the closed-loop system. To study in reality an experimental work is done to transfer packet data between two computer systems through a Local area Network (LAN) using UDP protocol. Subsequently the transfer of signal between two computer systems through a LAN using UDP protocol has been also made. These experiments were carried out using SIMULINK Instrument Control Toolbox (ver7.6). Networked predictive control is also designed for networked control of servo system. This control strategy is applied to a servo control system through the Local Area Network (LAN).SMITH-PREDICTOR proposed to compensate the communication delays in the networked control system.

Key words: NCS, LAN, Network

INTRODUCTION
Networks in the industrial arena have, in the past decade, revolutionized the way facilities are controlled. They have made centralized control centers possible, with a wider range of features and more flexibility than ever before. High data transfer rates have allowed for more efficient data storage, trending, alarming, and analysis. The drawbacks that plagued the early generations of networks have been solved, for the most part, making them reliable enough to be used in the most critical of applications. The definition of a network is two or more devices connected by some means so they can share information. The "means" is what we will address here. Additionally, even though the most general interpretation of the definition could include many manifestations, we will focus on data communication between devices commonly found in industry. If the problem is broken into manageable parts, we can deal with each one effectively. Network-based control has emerged as a topic of significant interest in the control community. It is well known that in many practical systems, the physical plant, controller, sensor and actuator are difficult to be located at the same place, and thus signals are required to be transmitted from one place to another. In modern industrial systems, these components are often connected over network media (typically digital band-limited serial communication channels), giving rise to the so-called networked control systems (NCSs). The study of Networked Control Systems (NCSs) brings together the historically separate disciplines of computer networks and control theory. Feedback control systems, wherein the loops used to control the behavior of a plant are closed through a real-time communication network, are called networked control systems. The defining feature of an NCS is that information is exchanged using a network among control system components (sensors, controller, and actuator).

Basic Networked Control System
A *networked control system* (*NCS*) is a feedback control system where the feedback loops are closed by means of an electronic network [1]. Figure 1.2 illustrates a typical networked control system. An NCS benefits its implementer by reduced cost, wiring, and system maintenance. However, NCSs are

not subject to the same design assumptions as non-networked continuous- and discrete-time systems, including fixed transmission period, fixed or no delay, and no data loss.

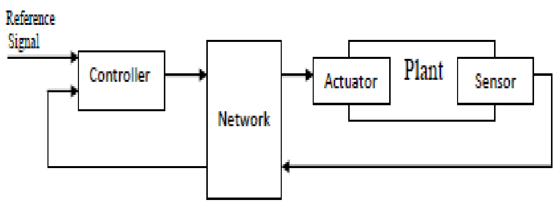

Figure 1.1. A block diagram of an NCS

FUNDAMENTAL ISSUES IN NCSs In this section, we will analyze some basic problems in NCSs, including network-induced delay, single-packet or multiple-packet transmission of plant inputs and outputs, and dropping of network packets.

Network-Induced Delay The basic problem in NCSs includes network-induced delays, single-packet or multiple-packet transmission of plant input and outputs, and dropping of network packets [47]. The network-induced delays in NCSs occur when sensors, actuators, and controllers exchange data packet across the communication network. This delay can degrade the performance of control systems designed without considering it and can even destabilize the system .

Single-Packet versus Multiple-Packet Transmission Single-packet transmission means that sensor or actuator data are lumped together into one network packet and transmitted at the same time, whereas in multiple-packet transmission, sensor or actuator data are transmitted in separate network packets, and they may not arrive at the controller and plant simultaneously. One reason for multiple- packet transmission is that packet-switched networks can only carry limited information in a single packet due to packet size constraints. Thus, large amounts of data must be broken into multiple packets to be transmitted. The other reason is that sensors and actuators in an NCS are often distributed over a large physical area, and it is impossible to put the data into one network packet. Conventional sampled-data systems assume that plant outputs and control inputs are delivered at the same time, which may not be true for NCSs with multiple-packet transmissions. Due to network access delays, the controller may not be able to receive all of the plant output updates at the time of the control calculation.

PID CONTROL DESIGN AND TUNING This thesis, we investigating PID controller design methods for processes with varying time-delays. In the case of varying time-delay systems the control strategy is hard to analyses with standard analytic control theory. In section the discrete-time PID controller is derived. It is later used to control a distributed system. Some practical aspects that have to be considered in PID controller design are put forth. Then some tuning methods that can be used for processes with varying time-delays are introduced.

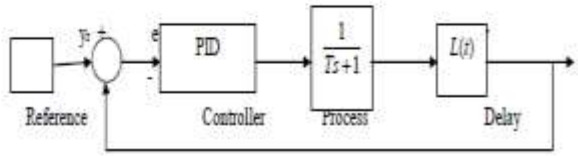

Figure.1.2. Model of a system with varying time-delay

SIMULATION RESULTS The PID controller tuning method presented in this Section on a step response. The process is a simple first order system with time constant T and transfer function. The controller is tuned for a process with time constant, T, in the interval [1, 10]. The sampling time of the controller is in the interval h = [0.1, 1].fig.2.6 show the step response of a system with constant delay.

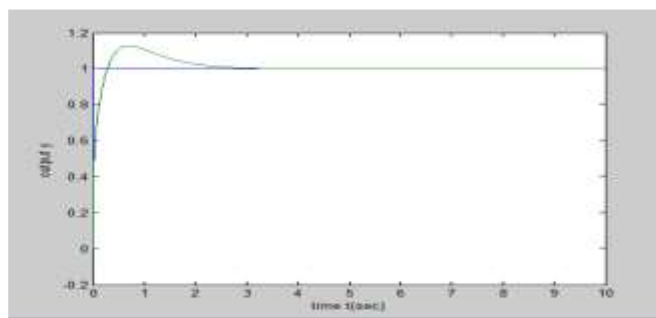

Fig.1.3.Step responses of model of a system with constant time-delay

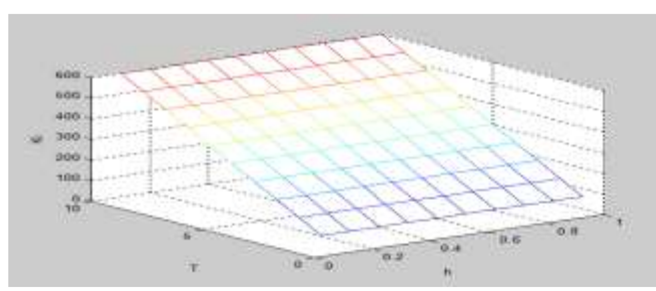

Fig.1.4.PID controller parameters for the first order system with constant delay

The optimal controller tuning is more conservative with increasing sampling time as the cost increases also. Some sampling times are relatively better than others, as 0.5 and 1.0, because they fit better the delay of 1. The best sampling time is the lowest, as it enables the controller the shortest response time on output changes.

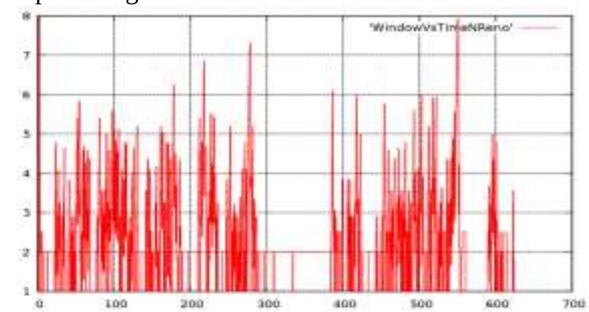

Fig 1.5. window size of TCP with 20% random loss

Fig 1.5. Shows the plot between the window and Time Reno created by the simulation. This simulation output will give when we introduce the simplest error model. we assume that packet are dropped on the forward link according independently with some fixed constant probability. This simulation graph is show the window size of TCP with 20% random loss. In this case we can observe long timeout, in particularly at time 300.To see the huge impact of the random loss on TCP performance.

Figure 1.6 shows the transmitting simulink block, this block put in host PC. For transmitting the signal from one system to another we are using the UDP protocol. These blocks will be available in MATLAB/simulink.UDP blocks mostly used for transmitting a signal or any data from one system to another through a LAN. These blocks works based on IP address of the systems.

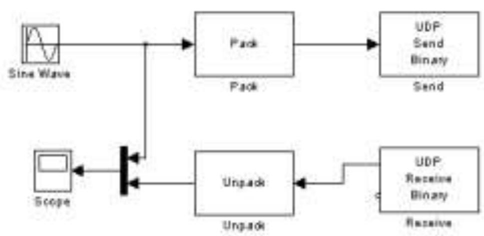

Fig 1.6. Transmitting simulink blocks in host PC

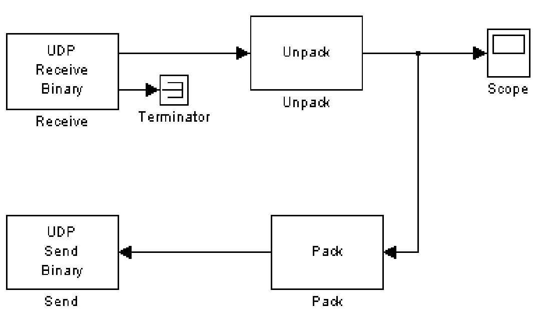

Fig 1.7. Receiving simulink blocks in remote PC

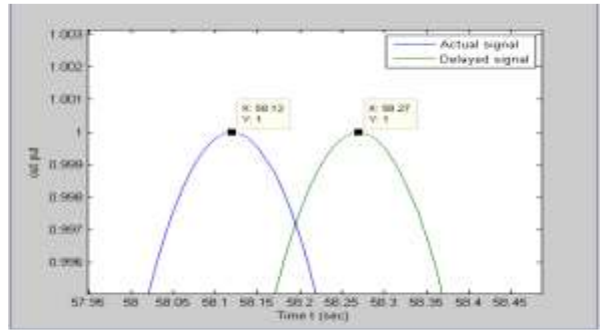

Fig.1.8. Measurement of Delay in Feedback loop

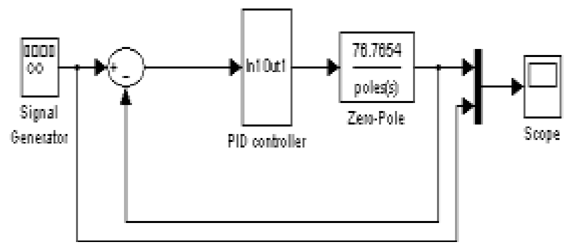

Fig.1.9. Simulink model of a system without network

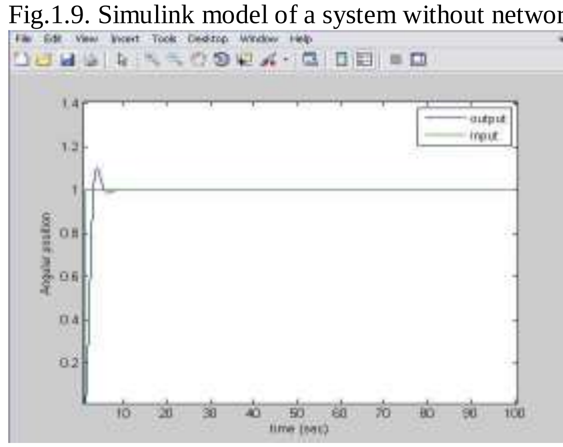

Fig.1.10. Step response of simulink model of a system without network

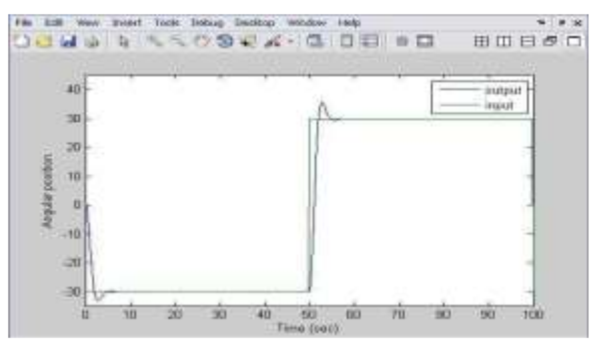

Fig.1.11. Response of simulink model of a system without network

Figure 1.12 represents the simulink model of a general PID controller. Input to the model is a square wave of amplitude 50v and frequency of 0.1 Hz with sampling time of 0.001sec.

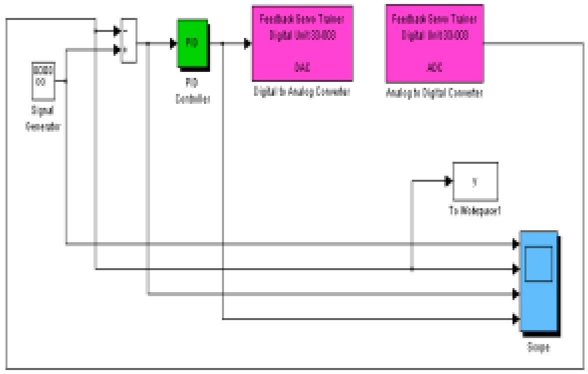

Fig.1.12.Simulink model of a general PID controller

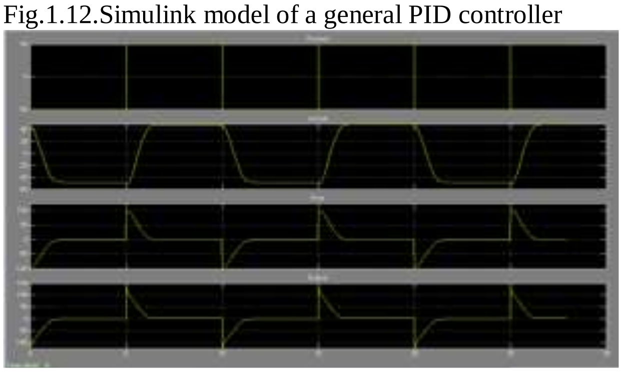

Fig 1.13. Response of a general PID controller

CONCLUSIONS

This paper presents study on Networked Control System, i.e., when control loops are closed over a communication network. As observed, communication network introduces time delays in the control loop. These delays may have effect on system stability and performance. The objective of the present work is to study delay compensation schemes in the feedback loop. Smith predictor is a well known compensation technique. Using this system stability and performance may be improved compared to without compensation of delays. The above said servo system is compatible with only MATLAB (version 6.5).and it is incompatible with higher versions of MATLAB. Due to this incompatibility the advance features available in higher version of MATLAB for our experiment cannot be implemented. This is the major disadvantage of the FEEDBACK SERVO.

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