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A Survey of Different Control Scheme for Network Control System

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*Abstract***— *the use of a data network in a control loop has gained increasing attentions in recent years due to its cost effective and flexible applications. The major challenges in this so-called Networked Control System (NCS) are the Network-induced delay and packet losses in the control loop. These challenges degrade the NCS control performance and destabilize the system. A significant emphasis has been on developing control methodologies to handle these problems in NCS. This survey paper presents recent NCS control techniques and also provides an overview on NCS structures and description of network delays including characteristics and effects are also covered.***

Keywords – Networked Control Systems (NCS}; Network Challenges – Delay and Packet Losses; A Survey.

I. INTRODUCTION

The robust PID controller is the modified form of PID controller in which the parameters of system are tuned to compensate for instability induce by time delays for non-minimum phase system and endows the system with robust safety margins in terms of gain and phase. According to modern control theory, the information (signals) are transmitted along perfect communication channels, which involve network communication. New controllers, algorithms and demonstration must be developed in which the basic input/output are data packets that may arrive at variable times not necessarily in orders and sometimes not at all. When PID controllers receive the sensor information or transmit its output through a communication network, its parameters are difficult to tune using classical tuning methods; this is due to the delays introduced by the network. Numerous control methods such as fuzzy control, neural control, adaptive control, nonlinear control and optimal control techniques and many more techniques are discussed in this paper.

II. DISTRIBUTED SYSTEM

There are two general NCS configurations as Direct and Hierarchical Structures. In Hierarchical Structure approach Fig.1 the plant is controlled by its own remote controller at remote station. The central controller provides the set point to the plant via remote controller and the sensor measurements of the system are sent from the remote station to central controller. The set points and sensor measurements are transmitted through network. This approach has a poor interaction between the central and remote unit because of not transmitting the control signal from central controller. The direct structure Fig. 1 approach uses the network for the direct transfer of the control signal and the sensor measurements between a remote unit and a central controller.

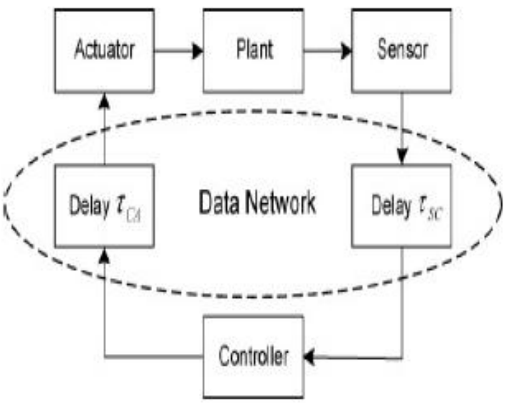

Figure 1. Distributed System

III. CONTROL TECHNIQUES – A SURVEY

In [1] – [2] a detailed survey of the state of the art of NCS are provided. The important problems of the real time data mining that are associated with large scale, the spatially distributed arrays of RF networked sensors, the real time data fission for heterogeneous and distributed arrays of sensors and distributed control and the communication for peer to peer

network to manage device node drop-outs and network reconfiguration strategies among others are discussed. In [3] a NCS model containing a clock driven sensors and event-driven controller and actuators are studied with comparison of both timings. The relationship between the sampling rate and network induced delay were analysed using stability region plot and using hybrid systems technique the NCS stability was analysed.
Fuzzy Modulated PID controller are discussed in [4], [8], [10] and [12]. [4] proposes the use of the fuzzy logic concept to modulate the system control gain of the PI controller for compensating the time delay problems in the network based controlled dc motor. For the compensation and improvement in the performance of the PI control under difference network delays & bandwidth the author has introduced a parameter β to the existing PI controllers control signal such that new control signal will be provided by the central controller. (where β is a nonlinear function that discrete the input /output relation of the fuzzy compensator).
PID controller was used in [5] - [6]. In [5] PID controller was used for networked DC motor control with network-induced delay. And in [6] NCS for motor speed control was implemented by using a Profibus –DP Network for the performance evaluation and also the author proposed a modified traditional design method for PID controller to minimize the effects of network delays on the system. Ziegler – Nichols method & Cohen Coon method were used to design the PID controllers with network and without network are compared in terms of maximum overshoots and settling time. 3.
The survey on control methodologies for NCS was provided in [8] . In [8] the author provided a survey on the control methodologies for networked induced delays as augmented deterministic discrete time model methodology, queuing method, optimal stochastic control method, perturbation method, sampling time scheduling method, robust control method, fuzzy logic modulation, event based method and end user control adaptation method for a closed loop control system over a data network with different applications and the paper also provided the NCS configuration, network delay characteristics and effects due to network delays.
Tipsuwan and Chow in [9] presented a gain scheduling approach for network traffic condition and enhanced the existing PI controllers for using over IP network. In part I [11] a partial adaptation scheme to tune the consequent parameters for the fuzzy logic modulator was presented and numerical simulation of a network-based controlled DC motor is used to illustrate the effectiveness of the proposed scheme over a direct PI controller parameter tuning. And in part II [10] the full adaptive fuzzy modulation (AFM), where both consequent parameters and membership functions parameters are tuned adaptively for further improvement in the performance of the system.Yong-Can Cao and Wei-dong Zhang [12] presented the classic PID controller for network delays in Networked Control Systems by adding the modified fuzzy controller which can dynamically adapt the change of delays because of the adaptation of the fuzzy logic. [7], [10] - [8], introduces fuzzy logic controller in control system. In [7] Remote Fuzzy Logic Control for servo motor control via Profibus-DP was proposed and compared it with the PID controller for compensation of network-induced delays. A self tuning Fuzzy Controller with first and second level controllers was designed [14] by the author to control a NCS with the presence of delay and packet losses. [13], [8] and [9] used Takagi-Sugeno (T-S) based fuzzy model in NCS for network induced delays and data packet loss challenges. The fuzzy $H\infty$ control scheme [20] for a class of NCS for both network-induced delay and packet dropout via the Fuzzy Estimator has been proposed via limited sampling information. The $H\infty$ T-S fuzzy control problem for systems with repeated scalar nonlinearities and random packet losses was investigated in [5] and in [6] T-S fuzzy model was used to model the nonlinear plant, and the communication link failure was modeled via a stochastic variable satisfying the Bernoulli random binary distribution.

IV. CONCLUSIONS

Networks and their applications play a promising role for real-time high performance networked control in industrial applications. The major concern which affects the performance of the networked control systems are the network induced delays and data losses. This paper describes various techniques to compensate the challenges described by different authors. The networked control system performance depends on the control algorithm and the network conditions with their applications.Depending upon the control algorithm and network conditions the overall performance of the networked system may vary and hence the stability of the system.

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