지능제어를 이용한 Profibus Network의 온라인 성능 관리

On-line Fuzzy Performance Management of Profibus Networks

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Abstract : This paper presents experimental results for performance management of a Profibus-FMS network. The performance management aims to maintain a uniform level of network performance at all stations under changing network traffic. The performance management algorithm monitors the performance of individual network stations and commands the stations to change their timer values in order to have comparable performance at all stations. In order to determine the amount of timer change, the algorithm employs a set of fuzzy rules. This algorithm has been evaluated on a Profibus network

Keywords : networking for manufacturing automation, fieldbus, Profibus, performance management, fuzzy logic

1. Introduction

Networking serves as communication links among islands of automation for further improvement in productivity in Computer Integrated Manufacturing (CIM). These networks are capable of interconnecting various standard-conforming devices from different vendors, which allows a system designer to be flexible on his/her initial design and future reconfigurations. This capability results in numerous advantages of networking for CIM and these include evolutionary system growth, better utilization of system resources, and improved reliability. Due to these benefits, networking is ideal for the role of the nerve system of advanced manufacturing systems where various and spatially distributed components and subsystems are integrated to realize a highly integrated manufacturing system. [1,2]

According to the area of application, a computer network should be tailored at the design stage by selecting appropriate network protocols and their parameters since requirements imposed on a network may widely vary. [1,2,3] Even after design and installation of a network, several groups of functions are required to adjust the network so that the initial design objectives are satisfied. This is because the condition under which a network operates may be different from that considered at the design stage. For example, in a manufacturing system network, the number of devices on the network will change continuously due to addition and deletion of devices for maintenance and repair. The network should be able to allow these changes without disrupting other devices on the network. Therefore, the network must always adapt to the dynamic environment, which is extremely essential because the network serves many crucial functions of the manufacturing system.

As a part of the network's adaptability, the networks require an ability to adjust their protocol parameters to maintain a certain level of performance. The protocol parameters include timer values and queue capacities, and the network performance is often expressed in terms of network delay and throughput. This ability belongs to the performance management of networks, and has become increasingly important because a network interconnects numerous devices that are very diverse in their communication requirements. One can easily imagine that a network on a common factory floor connects several PLCs, robots, conveyors, and various sensors, all of which have different transmission periods and maximum allowable delays. To make matters even more complicated, the characteristics of the network traffic are random and dynamic in nature due to common events like arrival of new production orders and failure in system components. [3,4,5]

As a case in point, Figure 1 shows the response of a motor that is remotely controlled via a fieldbus network, That is, the motor and its controller don't have any direct connection between them. Instead, they communicate with each other via the network. The encoder signal and the control command are sent through the network that is shared with other devices. The figure shows the motor speed under an identical traffic condition except different values for a protocol parameter (a kind of timer). The dotted curve represents the motor's response when the motor and the controller are directly connected. As can be seen in the figure, the responses obtained with the network are generally inferior to that with direct connection. Especially, it shows that an inappropriate choice for the protocol parameter can make the system unstable even under the same traffic. This example shows how important it is to make proper choices for protocol parameters.

This paper presents the development of an on-line fuzzy performance management procedure for Profibus-FMS networks. The management procedure is based on fuzzy rules to adjust a timer setting. The algorithm is designed to maintain uniform performance of all the stations even if the individual traffic loads are different. The developed procedure has been evaluated through experiments on the network that consists of six stations. The results showed that the management procedure was successfully adjust the timer to maintain uniform performance.

This paper is organized into five sections including this introduction. Section 2 gives a brief summary of Profibus-FMS protocols. The management algorithm and the network used for the development are described in Section 3. Section 4 describes the results of the experiment with fuzzy network performance manager(FNPM). Finally, conclusions are presented in Section 5.

2. Profibus FMS Protocols

Profibus-FMS is designed to have only three layers, i.e., physical, data link, and application layers, out of seven layers of the ISO OSI model. This is because the fieldbus network should support real-time communications among the devices on shop floors. Along with the three layers, it has an additional user layer and a management layer providing management services for all the layers. [6,7,8]

2.1 Physical and Data Link Layers

The physical layer is responsible for converting the data to be transmitted into transmission signals, propagating the signals to the

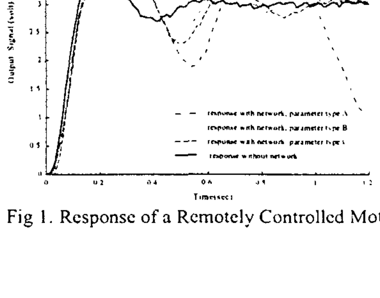

Fig 1. Response of a Remotely Controlled Motor