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FUZZY CONTROL OF ACTIVE QUEUE MANAGEMENT ROUTERS FOR TRANSMISSION CONTROL PROTOCOL NETWORKS VIA TIME-DELAY AFFINE TAKAGI-SUGENO FUZZY MODELS

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Abstract. *Active Queue Management (AQM) routers have been recently proposed to support the end-to-end congestion control in the Internet. In this paper, a fuzzy modeling technique is employed to set up a time-delay affine Takagi-Sugeno (T-S) fuzzy model for a Transmission Control Protocol (TCP) network with AQM routers. Based on the proposed time-delay affine T-S fuzzy model, a fuzzy controller design approach is developed for the control of AQM routers. It is shown that the proposed fuzzy controller design problem can be solved by the Iterative Linear Matrix Inequality (ILMI) algorithm. Finally, some numerical simulations of experiments are provided to illustrate the usefulness and effectiveness of the proposed design approach.*
Keywords: Time-delay affine Takagi-Sugeno fuzzy models, Iterative linear matrix inequality, AQM routers, TCP networks

1. **Introduction.** The congestion in computer network has been pointed out as an important problem because the data communicated in computer networks is increasing rapidly. As TCP being the usual protocol used to communicate between computers on the Internet, AQM router [16] was proposed to support the end-to-end congestion control for the TCP networks. The AQM mechanism can either drop or mark a packet as long as it detects incipient congestion. It has been a very active research area in the Internet community [7,16,20]. Several AQM schemes have been brought up to provide better stability, fairness, and responsiveness to dynamic changing workloads. Among the existing congestion control, Random Early Detection (RED) [12,21] is perhaps the most well-known queue-based AQM scheme, which introduces a control mechanism for randomized packet dropping with a queue length averaging technique. However, RED is sensitive to link's traffic load and its parameter setting. Thus, many approaches have been addressed to overcome these shortcomings [1,2,11,19,22,23]. These approaches include Random Exponential Marking (REM) [1], Dynamic Random Early Detection (DRED) [2], BLUE [11], Adaptive Virtual Queue (AVQ) [19], Stabilized Random Early Drop (SRED) [22] and Virtual Rate Control (VRC) [23]. Most of them are heuristic algorithm and only