Online Adaptive Fuzzy Logic Controller Using Genetic Algorithm and Neural Network for Networked Control Systems

Pooya Hajebi*, Seyed Mohammad Taghi AlModarresi*

**Department of Electrical and Computer Engineering, Yazd University, Yazd, Iran*

Hajebi@stu.yazd.ac.ir, smta@yazd.ac.ir

***Abstract*—Networked Control Systems are used for controlling remote plants via shared data communication networks such as Ethernet. These systems have found many applications in industrial, medical and space sciences fields. However there are some drawbacks in these systems, which make them challenging to design. One of the most common problems in these systems is the stochastic time delay. Packet switching in internet brings about the randomly varying time delay and consequently makes these systems instable. Convenient controllers such as PID and PI type controllers which are just matched with a constant time delay could not be a solution for these systems. Fuzzy logic controllers due to their nonlinear characteristic which is compatible with these systems are potentially a wise option for their control purpose. Fuzzy logic controller could become adaptive by means of neural networks and beneficial to deal with the varying time delay problem. Further, they do have more capabilities to tackle packet dropouts and dynamically system variables. This paper introduces a novel control method which addresses the varying time delay problem effectively. This novel method suggests an online adaptive fuzzy logic controller which has been controlled and adapted through the neural network. This method takes the advantage of the genetic algorithm to optimize the membership functions for its fuzzy logic controller. This designed controller is applied to an AC 400 W servo motor as a remote plant in order to control its position via Ethernet. The measurement of round-trip time (RTT) is used to estimate the online time delay as a parameter in online adaptive fuzzy logic controller. The rule-based table of designed fuzzy logic controller rotates in relation to this estimated time delay. The value of rotating is obtained from a trained neural network. Comparison of simulation results for different controllers indicates that this novel designed controller provides a better performance over the varying time delay. The proposed method follows the input easily, despite classical methods which result in an unstable system especially over the large time delays as large as 600 ms. Results get even more improved when genetic algorithm is applied to fuzzy logic controller.**

***Keyword*—Data Communication Networks, Genetic Algorithm, Networked Control Systems, Neural Networks, Online Adaptive Optimized Fuzzy Logic Controller, Rules-Table Rotation.**

Pooya Hajebi (S'10) was born in Isfahan, Iran, in 1981. He received the B.S. degree in electrical engineering (Electronics) and the M.S. degree in electrical engineering (Communication Systems) both from Yazd University, Yazd, Iran, in 2005 and 2009, respectively. Currently, He is working toward the Ph.D. degree in the Department of Electrical and Computer Engineering, Yazd University, Yazd, Iran. His research interests include Networked Control Systems, Fuzzy Systems, Neural Networks, Data Communication Networks, Digital Signal Processing, Biological Signal Processing, Digital Image Processing, Cellular Networks, Optimizations, Time Delay Systems and Real Time Systems.

Seyed Mohammad Taghi AlModarresi obtained his B.S. degree in Electronics Engineering and M.S. degree in Communication Systems, both from the Isfahan University of Technology, Isfahan, Iran. He also holds Ph.D. in Electronics (Intelligent Signal Processing) from University of Southampton, UK (Department of Electrical and Computer Science: ECS). He works at the Department of Electrical and Computer Engineering in Yazd University where he pursues his research interests in: (i) Networked Control Systems (NCS) (ii) Neuro-Fuzzy Networks (iii) Wireless Networks.