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AN IMPLEMENTATION OF THE NEURO-FUZZY INFERENCE CIRCUIT

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Abstract. *In this paper, we propose a neuro-fuzzy inference circuit applicable to real-time learning. We adopted a back-propagation algorithm used in the neural network for learning. The high speed learning is realized by using the parallel processing of the operations and tuning only the parameters of the consequent part. Furthermore, to reduce the circuit scale, we use the membership function of antecedent parts satisfying that the total of the degrees is equal to 1. Through the experimental use of the Field Programmable Gate Array (FPGA), we confirm that a high speed self-tuning of the fuzzy inference rules can be realized on the circuit.*
Keywords: Neuro-fuzzy inference circuit, Field programmable gate array, Self-tuning method, Triangular-type membership function

1. **Introduction.** Since L. A. Zadh proposed the idea of fuzzy logic [1] nearly 40 years ago, it has been used widely in the industrial world as a means of like industrial control or financial management [2-4]. The rules used in these fuzzy application systems have usually been determined by the experts or operators of these fields according to their knowledge or experiences. However, it is more difficult for us to give desirable fuzzy rules when an identifying system is very complicated. Thus learning techniques of fuzzy inference rules have been studied by many researchers in order to solve such problems [5-10]. Ichihashi [5,6], Nomura et al. [7,8], Wang and Mendel [9] have contrived the techniques by using the back-propagation algorithm of the neural network called "neuro-fuzzy learning algorithms" independently. However, as the authors discussed in [11], while these neuro-fuzzy techniques have high generative ability for tuning fuzzy rules, it is sometimes not reasonable and suitable for practical fuzzy applications, due to some disadvantages such as the weak-firing or non-firing.

Therefore, we have developed one of the neuro-fuzzy learning algorithms [12] designed to prevent the case of weak-firing or non-firing even after learning. However, since the