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ABSTRACT

Neuro-Fuzzy integrated systems have drawn attention of researchers working in different scientific and engineering fields due to the growing necessity of intelligent systems. In order to cater for this need, neuro-fuzzy integrated system with the provision of online learning capability and its VLSI design has been proposed. The proposed work is based on fuzzy if-then rules (structure learning) and the tuning of the parameters of membership function (parameter learning). To demonstrate capability of the proposed work, simulations for variety of applications in different domains have been carried out.

As it is impractical to extract if-then rules from a complex system, several approaches to generate fuzzy if-then rules from numerical data have been proposed in literature. The two learning phases mentioned in literature, are done sequentially; the structure learning phase is employed to decide the structure of fuzzy rules first and then the parameter learning phase is used to tune the coefficients of each rule. To overcome the problem of unsuitability for online operation, the learning process is done simultaneously instead of sequentially. This makes the proposed work suitable for fast online learning. Rules are created dynamically on receiving online training data by performing four processes.

The first process is to partition the input space into subregions. Various approaches have been defined to find a proper partition of the input space.

The second process is fuzzy rules and membership function generator. The generation of a new input cluster corresponds to the generation of a new fuzzy rule, with its pre-conditioned part as well as the consequent part of the generated rule is constructed by the learning algorithm. The

algorithm is based on the fact that different pre-conditions of different rules may be mapped to the same consequent fuzzy set.

The third process is verification of the generated fuzzy rules and membership functions. The important feature is optimization of no. of rules and membership function using neuro-fuzzy rule verifier which reduces memory requirement and execution time.

The final phase of optimal adjustment of the parameters of the network based on the same training pattern begins. Parameter learning is followed by structure learning, irrespective of whether the nodes (links) are newly added or existing originally.

Analog VLSI circuit has been incorporated for neuro-fuzzy integrated system**.** Analog fuzzy logic membership function circuit is built using a coupled differential amplifier as well as CMOS building block for realizing fuzzy membership function using OTA. Thereafter analog VLSI circuits of an on-chip learning neural network have been simulated. SPICE simulation showed its suitability to real time applications.

The successful attempt has been made to propose work that provides online learning capability and serves for variety of applications in different domains.