A Simple Digital-analog Circuit Suitable for Realization of Various Mathematical Operations for the Application in Artificial Neural Networks Implemented in Hardware

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Abstract

Various mathematical operations are used in artificial neural networks (ANN) to perform calculations according to given learning algorithms. The most typical operations include: summation, subtraction, multiplication, calculation of the sigmoid function (in synapses), etc [1, 2]. In case of ANNs realized in software realization of these operations is simple, as it usually requires only single instructions. A quite different situation appears in ANNs realized in hardware, especially as application specific integrated circuits (ASIC). In this case one of the main problems is to implement these operations in an efficient way at the transistor level [3]. In this work we propose a simple electronic circuit which depending on the parameters of particular elements (resistances or transistor sizes) can perform different mathematical operations. As a result, a single circuit can be used in various blocks of the ANN. The inputs of the circuit are digital multi-bit signals, while the output signal is the resultant voltage. The circuit is suitable for ANNs in which part of the operations are performed at the digital side, and part at the analog side. At digital side we perform operations directly related to the weights of the neurons, which are digital signal, while some parts of the learning algorithm are performed at the analog side. This approach protects the weights against the lost of information, while the operations which are hardware consuming can be realized using simpler analog circuits.

References

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