Analogue Neural Network Comparative Simulation by Means f MATLAB and PSPICE Software Products

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Abstract – **The most popular method used for the purpose of investigating a neural network's capability is that of simulation. While such a simulation ignores the parallelism issues inherent in neural networks, it nevertheless provides us to verify the proposed neural network's performance in an empirical setting rather then from a theoretical standpoint. In this paper, a comparison is made between the MATLAB and PSPICE simulation results.**

Keywords – **Neural networks, Analogue methods, Analogue models.**

I. Introduction

The simulation is the most popular method used for the purpose of investigating a neural network's capability. While such a simulation ignores the parallelism issues inherent in neural networks, it nevertheless provides us to verify the proposed neural network's performance in an empirical setting rather then from a theoretical standpoint. The aim of this paper is to investigate an analogue neural network cell propriety and a comparison is made between the MATLAB and PSPICE simulation results [2-5].

II. Matlab model

In last twenty years many researchers investigated a neural network computational model. Figure 1 depicts a simple model of neural network cell [1]. It consist of two building blocs. The first of them is an adder. It sum up the weighted input $\mathbf{w}_{ij}\mathbf{X}_i$. The second bloc transfers the sum which is the only argument of the transfer function **f**. The transfer function, typically is a step function or a sigmoid function, that takes the argument **h** and produces the output **Y**.

$$Y_j = f\left(\sum w_{ij} X_j + b\right) = f\left(h_j\right) \quad (1)$$

The transfer function that we use is a sigmoid function:

$$f\left(h_i\right) = \frac{1}{1 + e^{-h_i}}\ . \quad (2)$$

III. Pspice Model

A neural network cell presented as equivalent electrical scheme is shown on Fig. 2 [2-5]. The scheme include in-

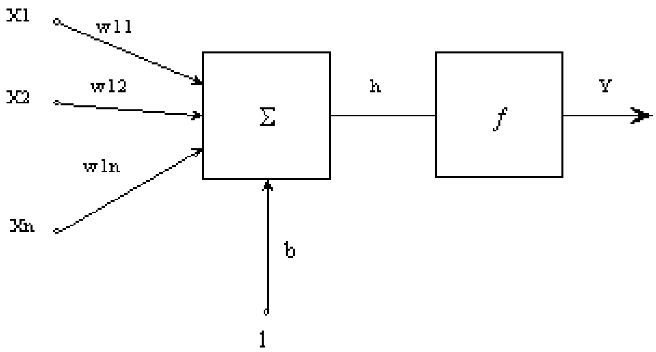

Fig. 1. A simple model of neural network cell.

dependent voltage source **E**, independent current source **I**, capacitor **C**, resistors $\mathbf{R}_1$,$\mathbf{R}_2$ and $\mathbf{R}_3$, linear voltage controlled current sources, and nonlinear voltage controlled current source.

The input signals are presented to the neural network cell as voltages $\mathbf{V}_1$, $\mathbf{V}_2$, ...,$\mathbf{V}_n$, which are converted into currents. Summation of the product of the weight and input occurs by injecting a current, proportional to the synaptic weight, into a summing node for the duration of each input signal.

The adder is realized by means of a resistor $\mathbf{R}_2$. The

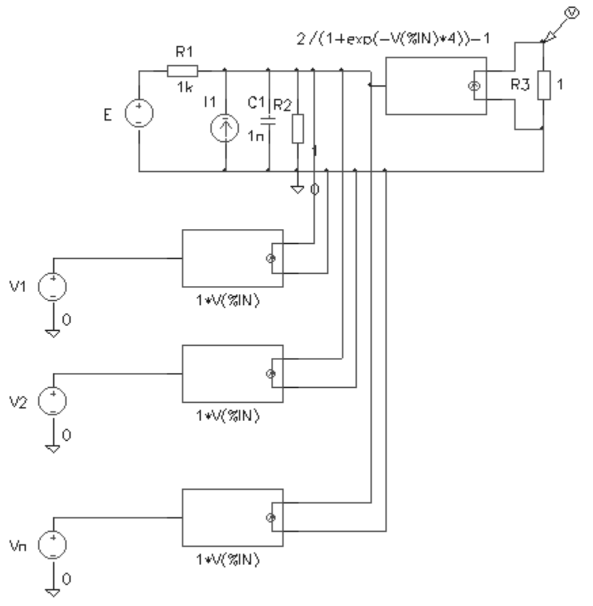

Fig. 2. A neural network cell presented as equivalent electrical scheme.

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currents produced by the linear voltage controlled current sources are passed into the summing resistor producing summation through Kirchhoff's current law.

In this paper are investigated static characteristics of the neural network cell. Then the neuron body voltage $\mathbf{U}_{z,j}$ is:

$$U_{z,j} = (I_1 + I_2 + ... + In + I) .R2 \,, \qquad (3)$$

where **I** correspond to the bias (**b**).

With nonlinear voltage controlled current source is realized the sigmoid transfer function and the output voltage is:

$$U_y = \frac{1}{1 + e^{-U_{z,j}}} \,. \qquad (4)$$

IV. Simulations Results

The mathematical model (Eq. 2) is modified in order to obtain output voltage range of -1 V to 1 V.

$$U_y = \frac{2}{1 + e^{-4U_{z,j}}} - 1 \qquad (5)$$

The simulation MATLAB result in case of **b=0, w$_{ij}$=1** and the input signal variation range is of -1 to 1 with variation step 0.1 is shown on Fig. 3. The simulation PSPICE result in case of **I$_1$=0, w$_{ij}$=1** and input signal variation range is of -1 V to 1 V with variation step 0.1 V is shown on Fig. 4.

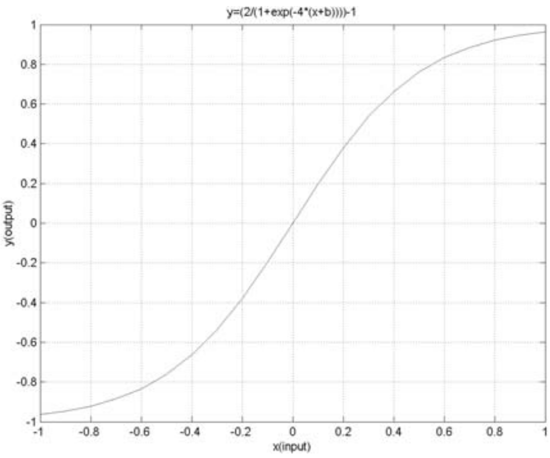

Fig. 3. The simulation MATLAB results **b=0, w$_{ij}$=1**.

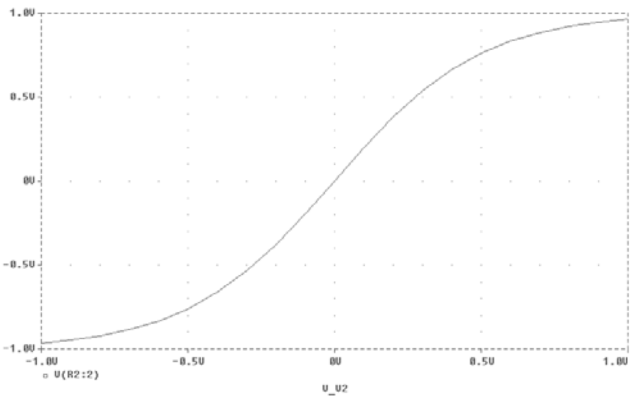

Fig. 4. The simulation PSPICE results **I$_1$=0, w$_{ij}$=1**.

The simulation MATLAB results in case of **w$_{ij}$=1**, input signal variation range is of -1 to 1 with variation step 0.1 and **b** variation range is of -1 to 1 with variation step 0.5 are shown on Fig. 5. The simulation PSPICE results in case of **w$_{ij}$=1**, input signal variation range is of -1 V to 1 V with variation step 0.1 V and **I$_1$** variation range is of -1 A to 1 A with variation step 0.5 A are shown on Fig. 6.

The simulation MATLAB results in case of **b=0**, input sig-

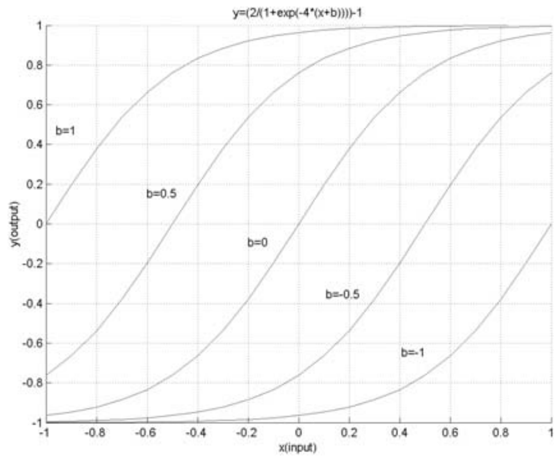

Fig. 5. The simulation MATLAB results **b=var, w$_{ij}$=1**.

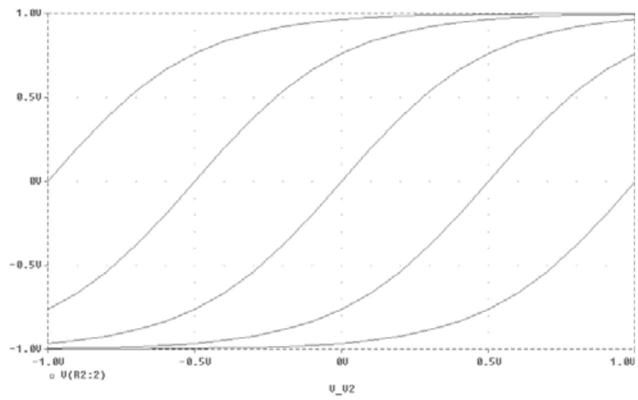

Fig. 6. The simulation PSPICE results **I$_1$=var, w$_{ij}$=1**.

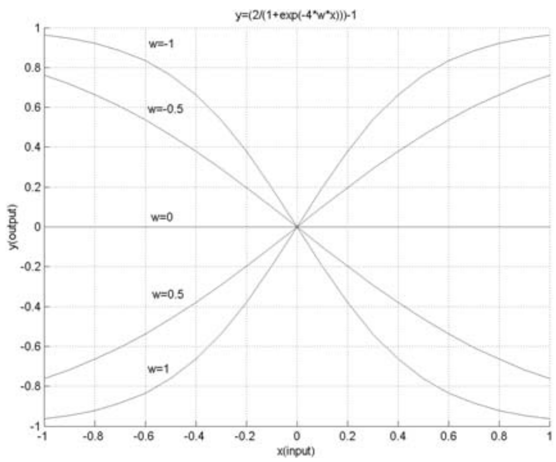

Fig. 7. The simulation MATLAB results **b=0, w$_{ij}$=var**.

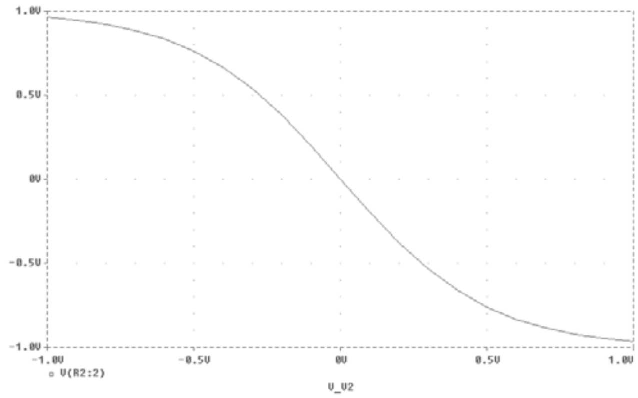

Fig. 8. The simulation PSPICE results $\mathbf{I}_1$**=0,** $\mathbf{w}_{ij}$**=-1**.

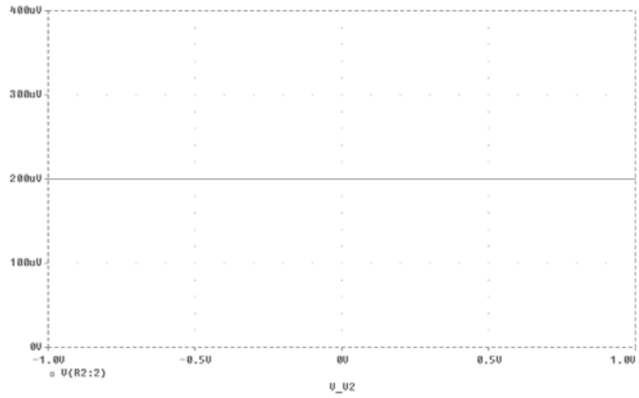

Fig. 9. The simulation PSPICE results $\mathbf{I}_1$**=0,** $\mathbf{w}_{ij}$**=0**.

nal variation range is of -1 to 1 with variation step 0.1 and **w** variation range is of -1 to 1 with variation step 0.5 are shown on Fig. 7. The simulation PSPICE results in case of $\mathbf{I}_1$**=0**, input signal variation range is of -1 V to 1 V with variation step 0.1 V and $\mathbf{w}_{ij}$ is respectively -1, 0, 1 are shown on Fig. 8, Fig. 9 and Fig. 10.

As shown of the presented above investigation (from Fig. 3 to Fig. 10) the analogue neural network cell model behavior is quite as the MATLAB mathematical model performance. Therefore the investigated analogue neural network cell model can be used to build neural networks.

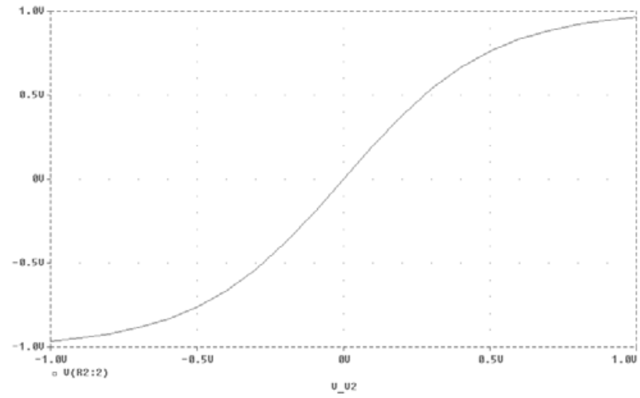

Fig. 10. The simulation PSPICE results $\mathbf{I}_1$**=0,** $\mathbf{w}_{ij}$**=1**.

V. Conclusion

In this article we presented a comparison between the MATLAB and PSPICE simulation results of an analogue neural network cell models. It is shown how the bias variation and the weigh variation influence over the output signal. Since, as the analogue neural network cell model behavior is quite as the MATLAB mathematical model performance, the investigated analogue neural network cell model can be used for neural networks building.

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