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RECOGNIZATION OF CHARACTER USING SPIKING NEURAL MODEL

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ABSTRACT

A spiking neural system (SNN) demonstrates is utilized to distinguish characters in a character set. The framework is a two layered structure involving consolidate and-fire and dynamic dendrite neurons. There is both excitatory and inhibitory relationship in the framework. It is discovered that the vast majority of the characters are perceived in a character set comprising of 26 letters in order characters. Spiking Neural Network genuinely mimics the acknowledgment ability like a human cerebrum natural occasion. This paper features the adequacy of sensible conduct of insight in a more reasonable manner and energy to perceive for time related slipped by occasions is conceivable just in SNN displaying

Keywords: Spiking Neural Network (SNN), Artificial Neural Network (ANN), Leakey Integrate & Fire (LIF), Spike Time Dependent Plasticity (STDP.

I. INTRODUCTION

All through the previous hundred years, scientists have been revealing an undeniably complex cerebrum structure. The basic handling units in the mind are the neurons, which are associated with each other in a perplexing example and can happen in numerous shapes and sizes. Neuron has four practically unmistakable parts, called dendritic tree, soma, axon and neurotransmitter. Generally, signals from different neurons are gathered by the dendrites (input gadget) and are transmitted to the soma (focal preparing unit). In the event that the aggregate excitation caused by the information is adequate, i.e., over an edge, a yield flag (activity potential, or spike) is discharged and proliferated along the axon (yield gadget) and its branches to different neurons. It is in the progress zone between the soma and the axon, the axon hillock, where the basic non-straight handling venture happens. The potential contrast between the inside of the phone (soma) and its surroundings is known as the film potential. This potential is specifically influenced by the postsynaptic possibilities – PSPs produced by the spikes got from presynaptic neurons. In the event that the layer potential achieves a limit, an activity potential (spike) is activated and conveyed through the axon and its branches to the postsynaptic neurons. In the event that the postsynaptic potential is certain, it is said to be excitatory (EPSP) [18] and if the change is negative, the neural connection is inhibitory (IPSP). The procedure of spike transmission through the axon has a related postponement, called the axonal deferral .

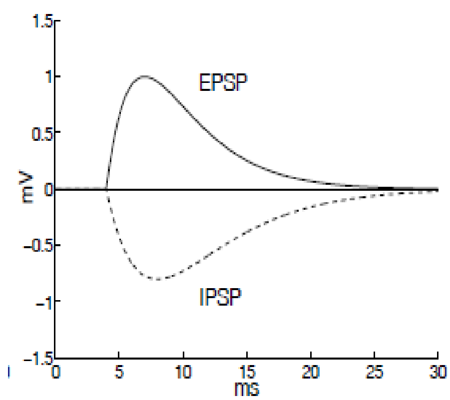

Fig. 1. Examples of action potential and EPSP and IPSP

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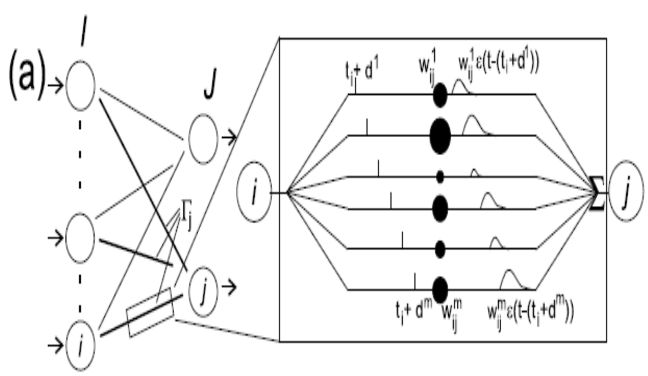
All works (SNNs) fall into the third era [13]of neural system models, expanding the level of authenticity in a neural re-enactment. Notwithstanding neuronal and synaptic state, SNNs additionally join the idea of time into their working model. The thought is that neurons in the SNN don't fire at every spread cycle (as it occurs with run of the mill multi-layer perceptron systems), yet rather fire just when a film potential - a natural nature of the neuron identified with its layer electrical charge - achieves a particular esteem. [4] [2] When a neuron fires, it creates a flag which goes to different neurons which, thus, increment or decline their possibilities as per this flag through the past hundred years, researchers have been uncovering a verifiably complex cerebrum structure..

With regards to spiking neural systems, the present initiation level (demonstrated as some differential condition) is typically thought to be the neuron's state, with approaching spikes pushing this esteem higher, and after that either terminating or rotting over the long run. Different coding strategies exist for deciphering the active spike prepare as a genuine esteem number, either depending on the recurrence of spikes, or the planning between spikes, to encode data. The possibility of one spike for each neuron to process data was investigated by [12].

II. LEAKY INTEGRATE AND FIRE

[25] Hopfield (1995) presents a model of spiking neurons for discovering clusters in an input space akin to Radial Basis Functions. Extending on Hopfield's idea, [3] Natschlager and Ruf (1998) propose a learning algorithm that performs unsupervised clustering in spiking neural networks using spiketimes as input. This model encodes the input patterns in the delays across its synapses and is shown to reliably find centers of high-dimensional clusters.

The network architecture consists of a feed forward network of spiking neurons with multiple delayed synaptic terminals (Figure 1.1 a and b). Spiking neurons generate action potentials, or spikes, when the internal neuron state variable, called `membrane potential or spikes. Relationship between input spikes and the internal state variable is described by the Spike Response Model (SRM), as introduced by Gerstner (1995). Depending on the choice of suitable spike response functions, one can adapt this model to reflect the dynamics of a large variety of different spiking neurons.



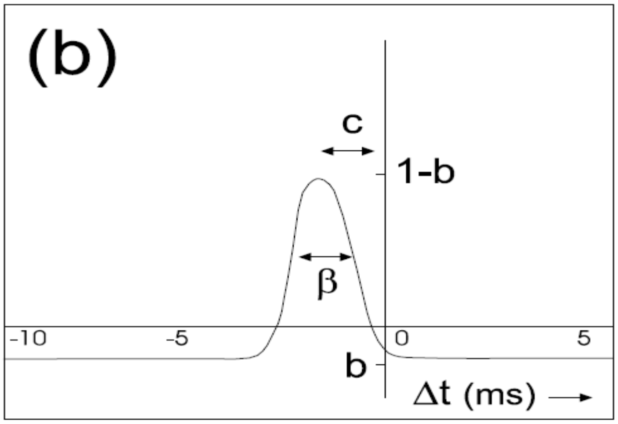


Fig.2 (a) and (b)

Figure 2(a) demonstrates organize network and a solitary association made out of different postponed neurotransmitters. Neurons in layer J get associations from neurons in layer I. Inset: a solitary association between two neurons comprises of m postponed synaptic terminals. A synaptic terminal k is related with a weight wijk , and delay dk. A spike from neuron I hence creates m postponed spike-reaction works, the whole of which produces the film potential in neuron j.

Figure 2 (b) is diagram of the learning capacity L(Δt). The parameter Δt .It signifies the time-distinction between the beginning of a PSP at a neurotransmitter and the season of the spike created in the objective neuron. An activity potential is a piece of the procedure that happens amid the terminating of a neuron. Amid the activity potential, some portion of the neural layer opens to permit decidedly charged particles inside the cell and adversely charged particles out.

This procedure causes a fast increment in the positive charge of the nerve fiber. At the point when the charge achieves +40 mv, the motivation is engendered down the nerve fiber. This electrical motivation is brought down the nerve through a progression of activity possibilities.

A. Prior to the Action Potential

At the point when a neuron isn't sending signals, within the neuron has a negative charge in respect to the positive charge outside the phone. Electrically charged chemicals known as particles keep up the adjust of positive and negative charges. Calcium contains two positive charges, sodium and potassium contain one positive charge and chloride contains a negative charge.

While very still, the cell film of the neuron enables certain particles to go through, while averting or limiting the development of different particles. In this state, sodium and potassium particles can't without much of a stretch go through the layer. Potassium particles, in any case, can uninhibitedly cross the layer. The contrarily particles within the cell can't cross the hindrance. The cell must movement transport particles to keep up its energized state. This system is known as the sodium-particle pump. For each two potassium particles that go through the layer, three sodium particles are directed out.

The resting capability of the neuron alludes to the distinction between the voltage inside and outside the neuron. The resting capability of the normal neuron is around - 70 millivolts, showing that within the cell is 70 millivolts not exactly the outside of the

B . Amid the Action Potential When a motivation is conveyed from a cell body, the sodium channels open and the positive sodium cells surge into the cell. Once the phone achieves a specific limit, an activity potential will fire, sending the electrical flag down the axon. Activity possibilities either happen or they don't; there is no such thing as a "fractional" terminating of a neuron. This guideline is known as the all-or-none law . After the neuron has let go, there is a stubborn period in which another activity potential isn't conceivable.

Amid this time, the potassium channels revive and the sodium channels close, step by step restoring the neuron to its resting potential. [17] The cracked coordinate and-fire (LIF) neuron show is a standout amongst the most fundamental formalisms of the spiking conduct of neurons. It is adequately a basic RC-circuit show (defective integrator) joined with a delta-work (fire) attached when the film potential achieves a given edge took after by a reset and discretionary unmanageable period.

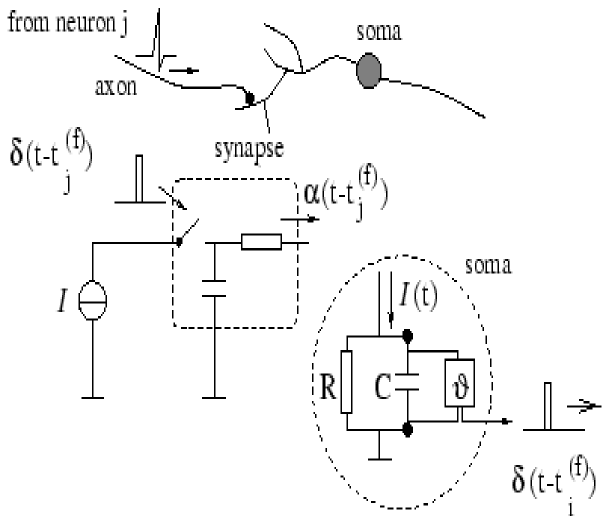


Fig. 3.

The While the LIF show has restricted premise physiologically, its quality lies in its computationally straightforward capacity to create spike occasions with an information driven recurrence. The LIF demonstrate is communicated as the single differential condition,

$$\frac{dV}{dt} = \frac{1}{\tau_m}(-V + IR_m)$$

where V is the film potential, rm is the layer time consistent equivalent to R_m*C_m, the identical protection and capacitance of the neural film, individually, and I is the info current. Including an obstinate period just transforms this into the piecewise condition

$$\frac{dV}{dt} = \begin{cases} \frac{1}{\tau_m}(-V + IR_m) & t > t_{rest} \\ 0 & \text{otherwise} \end{cases},$$

where t_ref is the time at which the neuron's hard-headed period closes. An illustration hint of a LIF neuron's film potential after some time for a steady info it demonstrated as follows.

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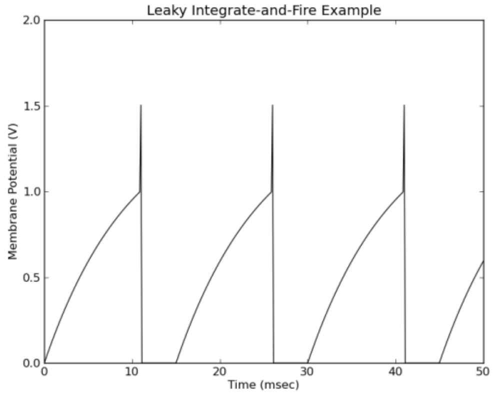

Fig. 4. Charging and Spiking state of neuron as per differential equation

III. MODELING WITH SNN

Natural Neural Network (BNN) Toolbox is MATLAB-based programming to re-enact system of organic reasonable neurons, as a unique model of mind and Central Nervous System.

This product empowers client to make and reproduce different BNN models effortlessly, utilizing worked in library models, and just in a couple of lines of code. Client can likewise make custom models and add them to the library, utilizing library formats. An arrangement of exceptionally engaging cases are accessible to give a speedy prologue to the tool compartment and to lessen the coding time for software engineers. What's more this tool compartment just covers spiking models of neurons and organically conceivable system parts. To reenact terminating rate models, there exists exceptionally very much planned bundles, for example, Neural Network Toolbox of MATLAB. This tool kit utilizes intense MATLAB programming dialect. MATLAB is a well known calculation stage with profoundly particular and effective tool stash for most logical and building fields. This tool kit is made and created for demonstrating cerebrum and CNS and is given to different clients as an open source free programming under GNU GPL3.

The primary objective of this product is to give clients an arrangement of incorporated apparatuses to make models of organic neural systems and reproduce them effectively, without the need of broad coding. Clients can make and reproduce a tremendous system of spiking neurons in under 10 lines of code (or even in one line, on the off chance that they give all contentions to the fundamental capacity) utilizing predefined library capacities. It is additionally conceivable to make and add new models to the library effortlessly, utilizing format library things accommodated this reason. Since programming in MATLAB is currently extremely well known, clients likewise would have the advantages of different tool compartments to expand their code and models effectively.

IV. RESULTS

For initial testing, the network was trained using twenty six alphabets ('A', 'B', 'C', and till 'Z'). There were 35 input neurons and 26 output neurons for this case. The binary pattern of characters is as shown in figure.

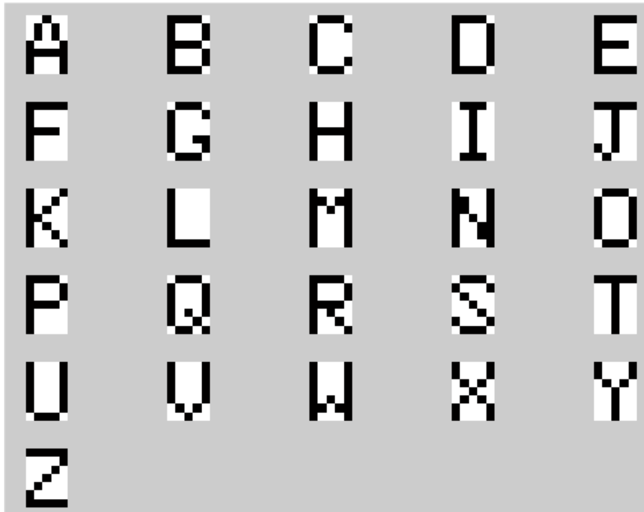

Fig. 5. Character set used

Figure shows the soma potentials of all the 1st and 3rd neuron after training on presentation of a single character. Similar observations were made with rest of the characters.

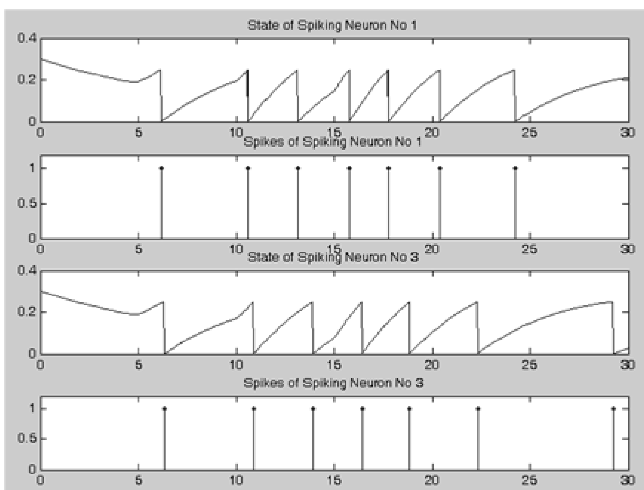

Fig.6. Activation Potential and Firing spikes of Neuron 1 and Neuron 3 for recognition of character "A" and character "C"

All neurons and their spikes are as shown in figure.

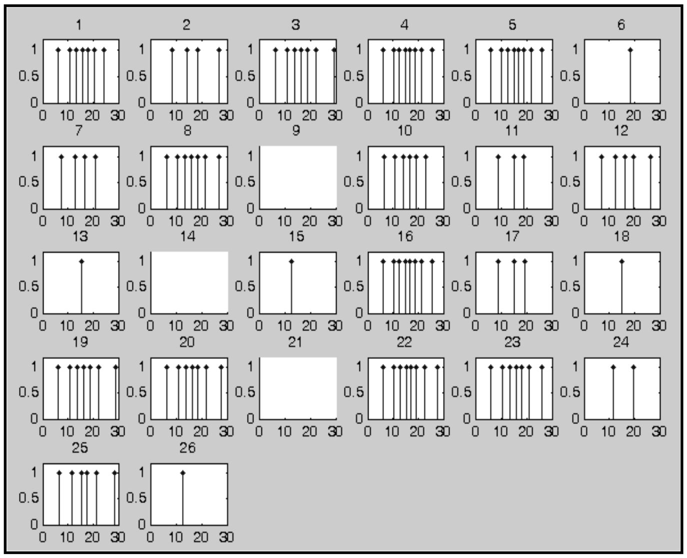

Fig. 7. Spiking Pattern of 2

Spiking Neurons

Plot of Sum Squared Error during the process of ANN based recognition is as shown.

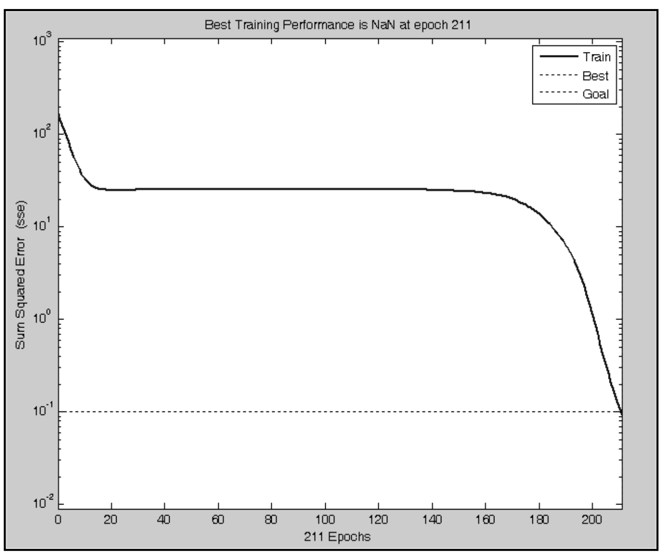

Fig.8. Plot of Sum Square Error for ANN

Final result of Recognition is as shown here clearly showing the difference between ANN and SNN.

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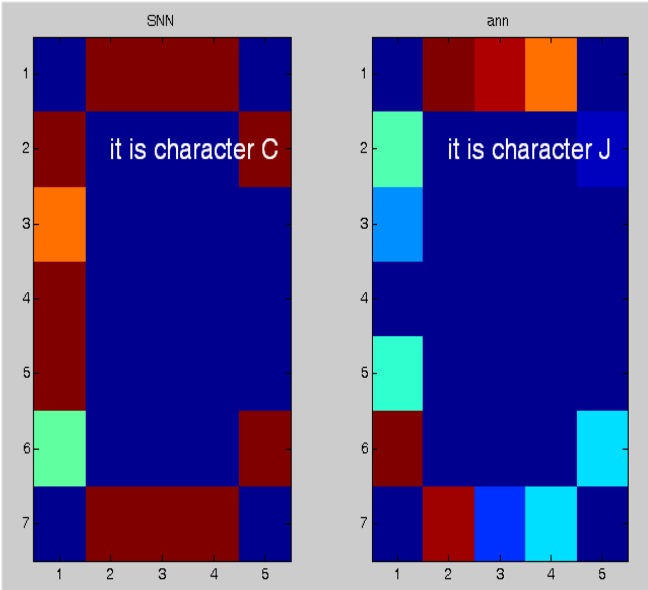

Fig.9. SNN and ANN Recognition of Letter C at a specific instant.

Following Table Summarises the accuracies and Errors involved during the process of recognition.

Table : Experimental Results of Character Recogniton using Biological Spiking Neurons and Artificial Perceptron Based Neurons.

Total Number of Time instants for Recognition of Characters	% of Correctly Recognised Characters over 30 microseconds using ANN	% of Correctly Recognised Characters over 30 microseconds using SNN	% of Correctly Recognised NOISY Characters over 30 microseconds using ANN	% of Correctly Recognised NOISY Characters over 30 microseconds using SNN
1696	98.18	100	91.23	98.23
1750	97.25	100	85.19	96.87
2030	96.12	99.23	82.54	95.23
1580	99.12	100	93.23	99.57

Figures 5, 6, 7, 8, 9 and 10 show the output of all the twenty six Spiking Neurons when the character 'C' is presented as input after training using ANN and SNN. We can see that only SNN has accurate and quick capability due to integration of past memory (inputs).

V. FUTURE SCOPE

In this paper exactness of acknowledgment of character start to finish is more if there should be an occurrence of Spiking Neural Network Model. There is an extent of acknowledgment of numeric keys and uncommon character utilizing SNN. Preparatory outcomes look empowering and more unpredictable issues, for example, picture acknowledgment will be attempted later on.

VI. CONCLUSION

From the outcomes got we can reason that precision of acknowledgment is more if there should arise an occurrence of spiking neural system show when contrasted with Artificial Neural Network. A two layered spiking neural system was utilized to distinguish characters in a character set. [5] [15 [18] [19] [20] [21][22] STDP was utilized to prepare the system. The system was prepared until the point that no critical weight change was watched. A large portion of the characters were perceived when the system was prepared utilizing a character set of 26 characters. The system was effectively prepared with characters of expanded resolutions. The system could perceive characters after expansion of arbitrary clamor pixels. Development of the weights amid preparing demonstrates that each yield neuron modifies the incentive towards the coveted yield.

REFERENCES

1. *Ankur Gupta and Lyle N Long "Character Recognition using Spiking Neural Networks. "*
2. *S. Thorpe, A. Delorme, and R. van Rullen, "Spike based strategies for rapid processing," Neural Networks, vol. 14, pp. 715–726, 2001.*
3. *T. Natschlager and B. Ruf, "Spatial and temporal pattern analysis via spiking neurons," Network: Comput. Neural Syst., vol. 9, pp. 319–33 ,*
4. *1998.*
5. *W. Gerstner, R. Kempter, J. L. van Hemmen, and H. Wagner, Hebbian Learning of Pulse Timing in the Barn Owl Auditory System, ser. Pulsed Neural Networks, W. Maass and C. M. Bishop, Eds. Berlin, Germany: MIT-press, 1999.*
6. *C. Panchev and S. Wermter, "Spike timing dependent synaptic plasticity: from single spikes to spike trains," Neurocomputing, vol. 58-60, pp. 365–371, 2004.*
7. *Gerstner W. Kistler, 2002 "Spiking Neural Model Single Neuron, population, and plasticity Cambridge university.''United Kingdom, May 2005.*
8. *C. Panchev and S. Wermter, "Temporal sequence detection with spiking neurons: Towards recognizing robot language instruction," Connection Science, vol. 18, pp. 1–22, 2006.*
9. *A. R. Baig, "Spatial-temporal artificial neurons applied to online cursive handwritten character recognition," in European Symposium on Artificial Neural Networks, April 2004, paper Bruges (Belgium), pp. 561–566.*
10. *D. V. Buonomano and M. M. Merzenich, "A neural network model of temporal code generation and position invariant pattern recognition,"Neural Computation, vol. 11, pp. 103–116, 1999.*
11. *S. Jaramillo and F. Pereira, "Recognition of dynamic patterns with a network of spiking neurons." [Online]. Available:*
12. *http://www.cs.unm.edu/ sjara/docs/Jaramillo and Pereira CSSS2002.pdf*
13. *R. van Rullen, J. Gautrais, A. Delorme, and S. Thorpe, "Face processing using one spike per neurone," Biosystems, vol. 48, pp. 229–239, 1998.*
14. *C. J. Bruce, R. Desimone, and C. G. Gross, "Visual properties of neurons in a polysensory area in superior temporal sulcus of the macaque,"*
15. *Journal of Neurophysiology, vol. 46, pp. 369–384, 1981.*
16. *W.Maass "Network of Spiking Neurons, the third generation of Neural Network Models Neural Network 10,1997.*
17. *[14] D. A. Jeffreys, "Evoked potential studies of face and object processing," Visual Cognition, vol. 3, pp. 1–38, 1996.*
18. *A. Delorme and S. J. Thorpe, "Face identification using one spike per neuron: resistance to image degradations," Neural Networks, vol. 14, pp. 795–804, 2001.*
19. *S. Haykin, Neural Networks: A Comprehensive Foundation. Upper Saddle River, NJ: Prentice-Hall, 1999.*
20. *C. Panchev, S. Wermter, and H. Chen, "Spike-timing dependent competitive learning of integrate-and-fire neurons with active dendrites,"*

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Impact Factor- 5.070