Supporting Information for "Spike Enabled Audio Learning in Multilevel Synaptic Memristor Array Based Spiking Neural Network"

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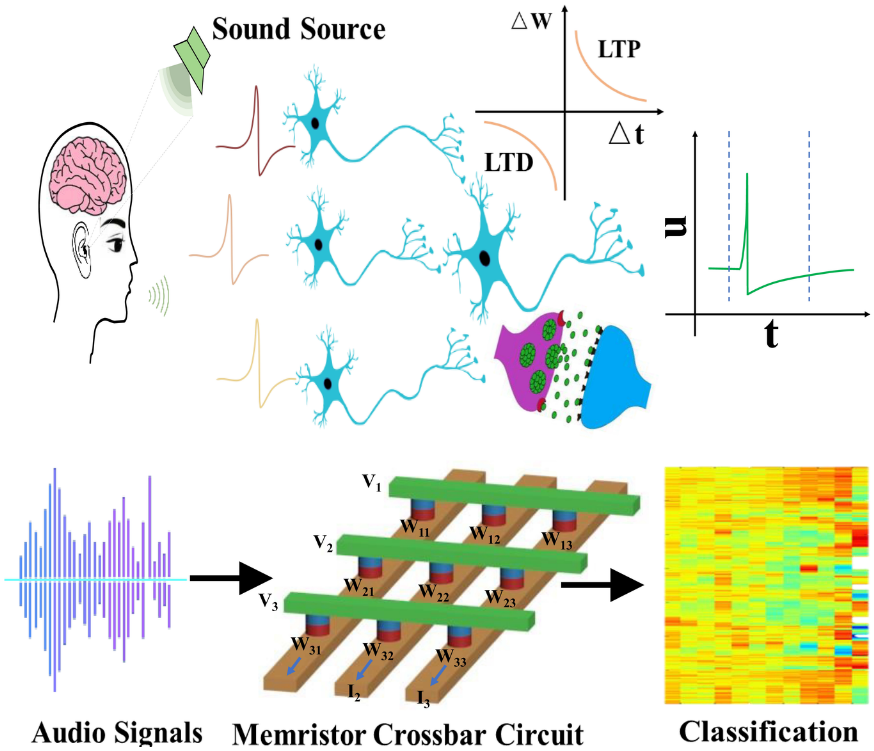
Abstract

Although speech recognition has been widely implemented in software neural networks, a hardware implementation based on energy efficient computing architecture is still missing. In this study, we have fabricated $W/MgO/SiO_2/Mo$ memristor array with multilevel resistance states, where the weights of the artificial synapses in the memristor array can be tuned precisely by voltage pulses. Based on the array, we have performed speech recognition in memristive spiking neural network (SNN) with improved supervised tempotron algorithm on TIDGITS dataset , demonstrating software-comparable accuracy for speech recognition in the memristive SNN. We envision that such memristive SNN can pave the way to building a bio-inspired spike-based neuromorphic system for audio learning.

ToC Figure



Here we report a W/MgO/SiO_2/Mo memristor array with multilevel resistance states, where the weights of the memristor array can be tuned precisely by voltage pulses. Based on the array, we have performed speech recognition in memristive spiking neural network with improved supervised tempotron algorithm on TIDIGITS dataset, demonstrating software-comparable accuracy for speech recognition in the memristive spiking neural network.

Supporting Information

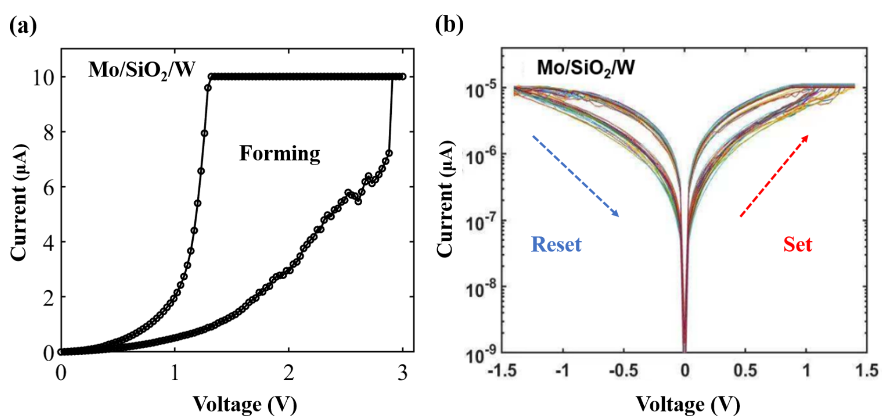


Figure S1.(a) The forming operation of the Mo/SiO_2/W device under the +3 V DC sweeping voltages at room temperature. (b) The *I-V* characteristics of the Mo/SiO_2/W device with +1.45 V/-1.45 V write/erase voltages in 50 repeated DC sweeps, showing the resistive switching behaviors.

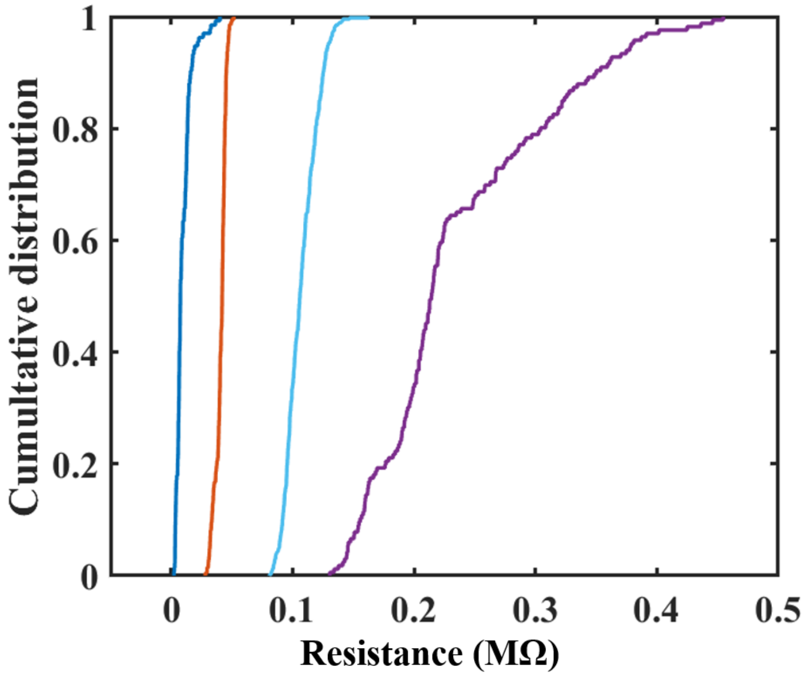


Figure S2. The cumulative distribution of resistance states of the Mo/SiO_2/MgO/W devices.

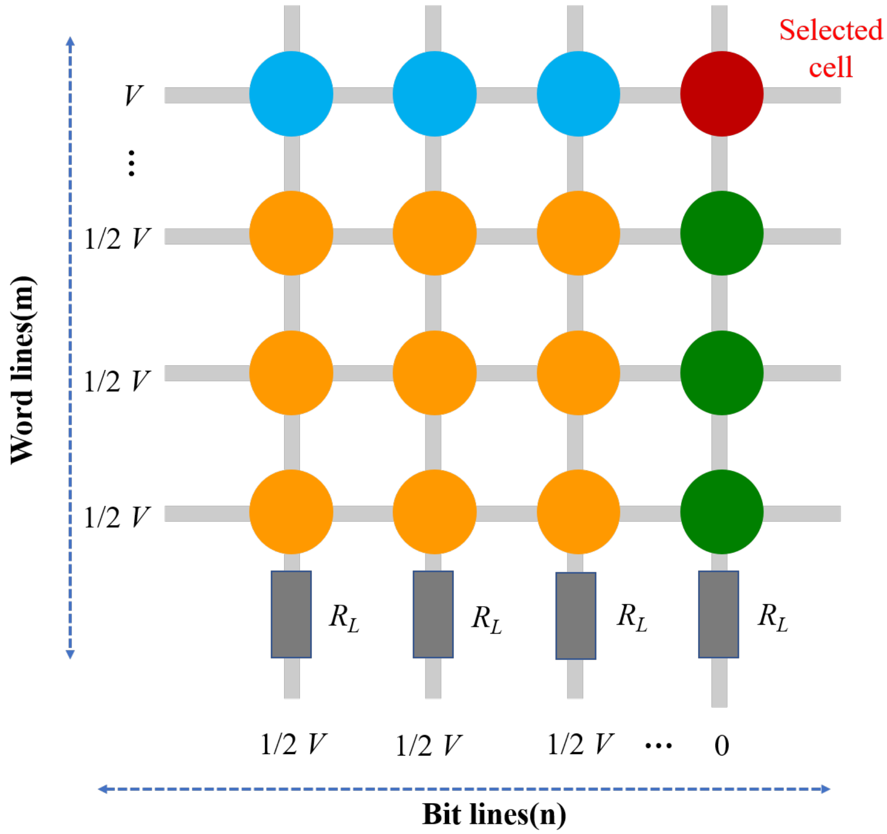


Figure S3. The write/erase and read programming method in the memristors-array based on the one-half voltage (V/2) bias scheme.

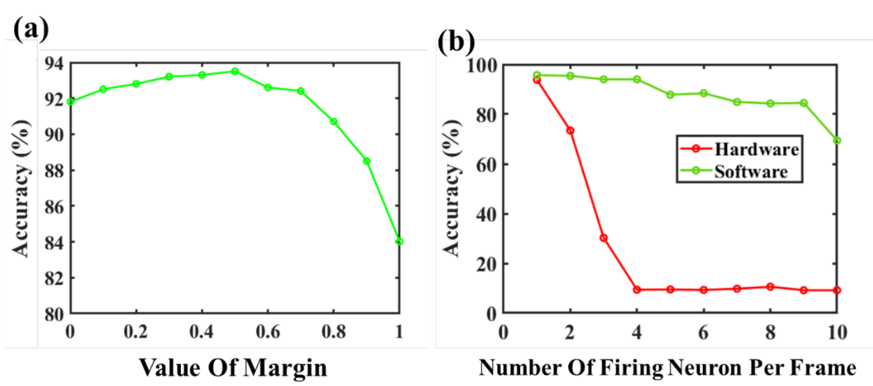


Figure S4. (a) The effect of the hard margin [?] on classification accuracy. For [?]=0, the modified learning rule is reduced to the classical Tempotron rule. (b) The effect of the number of activated output neurons in the SOM for each sound frame.

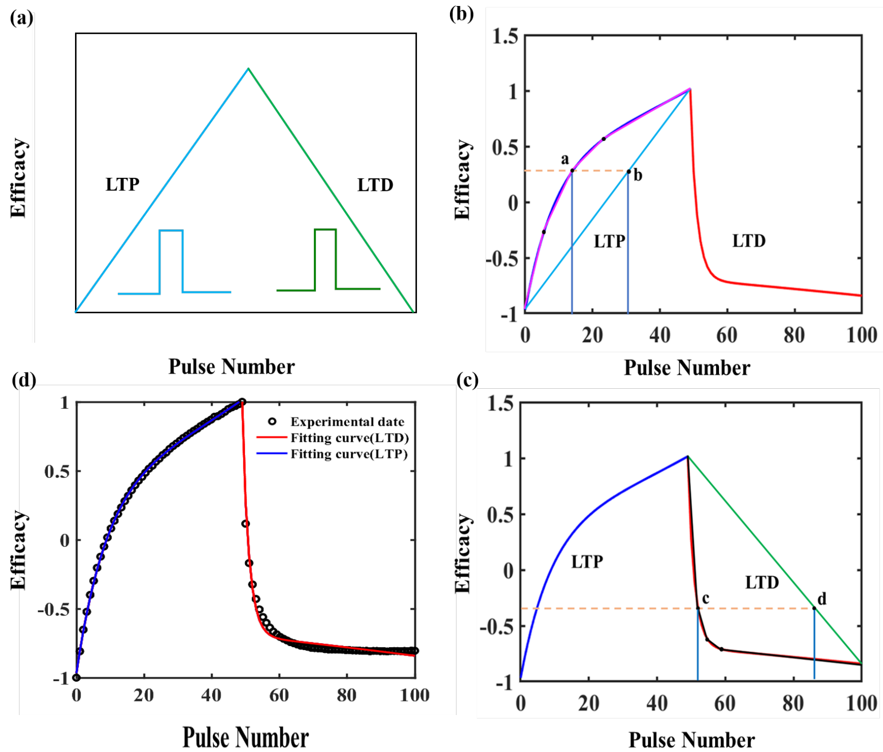


Figure S5. (a) The ideal and symmetric LTP and LTD. (b) Piecewise linear approximation of LTP. (c) Piecewise linear approximation of LTD. (d) The experimental data quantified and fitting curve of LTP and LTD.

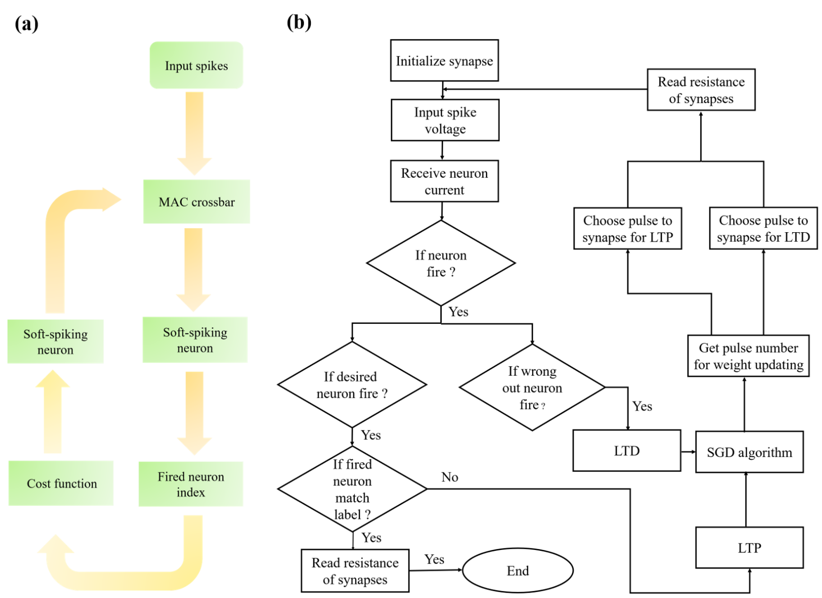


Figure S6. (a) Flow chart of the simulation process. (b) Flow chart of the training process.

Supplementary Movie1

Rich media available at https://youtu.be/tmy9bfasjZU

Supplementary Movie2

Rich media available at https://youtu.be/y_WFbKq4Jw4

References

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