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**Title:** Predicting COVID-19 Infection Using a Combination of RRAM-enabled Neuromorphic Hardware and Multiplexed Antibody Testing

**Abstract:** Determining an individual's immune response to COVID-19 infection or vaccination and the maintenance of antibody levels over time is critical for predicting disease and for epidemiological monitoring efforts. We recently demonstrated the use of a plasmonic enhanced fluorescence approach to measure individual antibody levels in human blood samples either with or without prior COVID-19 infection. In this prior study, measurably different levels of antibodies against multiple COVID-19 antigens were found (including portions of the spike protein S1, S1S2 and the internal nucleocapsid protein). Using an energy efficient neuromorphic hardware-based recognition approach, we trained a simple neural network to predict infection history based on relative levels of antibodies against viral antigens. This network was implemented on (Resistive Random Access Memory) RRAM-enabled hardware using pre-trained weights. The small feed-forward, spiking neural network is more desirable than conventional artificial neural networks because of its smaller size and lower power consumption. A spiking neural network as small as only 8 neurons, with 3 synapses for each neuron yielded results that are comparable or better to similar artificial neural networks at predicting whether a sample was from a subject with confirmed COVID-19 infection history vs. uninfected individuals. We implemented the neural network model on 8x8 1 transistor – 1 RRAM (1T1R) arrays consisting of hafnium oxide-based RRAM integrated with 65nm CMOS transistors in the SUNY Polytechnic 300mm nanofabrication facility. The weight of the trained neural network was represented by analog resistive levels in 1T1R cells within these arrays and experimentally performed multiply and accumulate (MAC) functions for each neuron using 8x8 1T1R arrays. Our hardware results combined with software simulation shows 84.6% accuracy in correctly identifying infection based on measured antibody levels. Furthermore, using our plasmonic sensor platform, we measured samples before and after infection with or without vaccination against 2019 SARS CoV2 (COVID-19) groups of individuals based upon exposure. Our ongoing work is focused on testing the expanded data set and optimizing hardware implementation of the neural network.