



Non-volatile matrix multiplier

A compact, low-energy, non-volatile nanomagnetic matrix multiplier as a hardware accelerator for machine learning and artificial intelligence

Many, if not most, artificial intelligence and machine learning paradigms rely on large matrix multiplications to execute algorithms. Software approaches for matrix multiplication are the norm, but they are slow and vulnerable to cyberattacks. Hardware matrix multipliers are much faster. Current electronic charge-based matrix multipliers are fast but volatile and hence cannot store the results of the matrix multiplication in-situ. Optical multipliers are also usually volatile and in addition have very large footprints. They must store the results in a remote memory or server (usually the cloud), which makes them cyber-insecure and energy inefficient.

The technology

A VCU researcher has developed a novel technology for an analog matrix multiplier using two magnetic tunnel junctions. This novel technology is an all-magnetic matrix multiplier, which is *non-volatile* and does not need to store the results in a remote location. This allows safe and secure edge computing. The energy dissipated for a single multiply-and-accumulate operation is ~ 100 aJ, which is comparable to the energy dissipated by a single transistor in today's electronic chips. The entire multiplier (with peripherals) occupies an area less than $1 \mu\text{m}^2$. The device is non-volatile and extremely energy-efficient (low energy dissipation); this extremely low energy dissipation offers many advantages and even enhances cyber-resilience by making it easier to detect concealed hardware Trojans. This makes it very attractive for artificial intelligence, deep learning neural networks and machine learning.

Benefits

- » Non-volatile
- » Compact
- » Energy efficient
- » Provides more cybersecurity

Applications

- » Smart appliances
- » Self-driving vehicles
- » Patient monitoring
- » Smart energy grid

Patent status:

Patent pending: U.S. and foreign rights are available.

License status:

This technology is available for licensing to industry for further development and commercialization.

Category:

Engineering and Physical Science

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