MIRRORSEED PROJECT

Sustainable Neuromorphic AI
for Earth & Space

Symbolic Resonance Array (SRA) for Smallsats

Ultra-Low-Power Neuromorphic Architecture for Onboard Autonomy

Problem Statement

Small spacecraft and CubeSats are constrained by size, weight, and power (SWaP). Traditional digital processors consume excessive energy, limiting the ability to perform onboard decision-making, autonomy, and real-time science processing. These constraints force frequent reliance on ground control, creating delays and bandwidth bottlenecks.

Innovation

The Symbolic Resonance Array (SRA) is a new analog neuromorphic architecture that replaces code-based AI with a matter-based, energy-efficient computing framework.

- **Energy Efficiency:** Targets sub-picojoule operations, orders of magnitude lower than conventional digital hardware.
- **Autonomy:** Enables onboard classification, anomaly detection, and adaptive control without ground intervention.
- **Resilience:** Analog crystal-based switching offers inherent radiation tolerance and robustness in extreme environments.
- Scalability: Compact form factor suitable for CubeSat payload integration, with the ability to scale to larger architectures.

Benefits for Small Spacecraft

- **Extended Mission Life:** Reduced power demand preserves limited energy budgets.
- **Enhanced Autonomy:** Real-time decision-making enables spacecraft to adapt to unexpected events.

- **Improved Science Return:** Data can be pre-processed onboard, reducing downlink requirements.
- **Technology Demonstration**: Provides NASA with a novel computational subsystem for future lunar, Martian, and deep-space missions.

Proposed Flight Demonstration

- Integrate SRA as an experimental payload on a CubeSat platform.
- Demonstrate onboard pattern recognition and adaptive control in orbit under tight SWaP conditions.
- Compare SRA energy/latency performance against digital baselines.

Next Steps

- Submit under NASA SBIR/STTR 2026 Phase I in computing/autonomy topic areas.
- Explore collaboration via the Small Spacecraft Systems Virtual Institute (S3VI).
- Pursue NASA Flight Opportunities for suborbital/LEO testing of a prototype SRA unit.

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