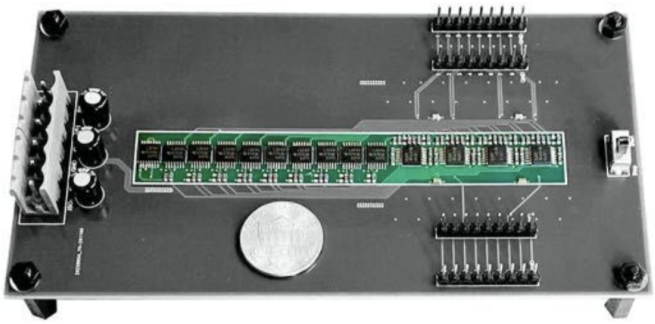
Docket #: S20-520

Hybrid analog/digital circuit for solving non-linear programming problems in real-time

Edge optimization is broadly needed to ensure the efficient, reliable, and optimal operation of a variety of energy systems, including distributed energy resources (DERs) installed at the grid edge, EV charging infrastructure, and building HVAC equipment. However, it is becoming clear that conventional digital microcontrollers (MCUs) are largely insufficient for implementing edge optimization techniques because they greatly lack the needed performance-per-watt for edge applications.

Addressing these issues, this invention is a fast and energy-efficient computational platform suitable for edge optimization of distributed energy systems. The core technology is a mixed-signal computing system composed of a digitally-assisted analog circuit that computes solutions to constrained nonlinear optimization problems in real-time. The technology is fundamentally unlike any commercial MCU currently on the market and can enable orders-of-magnitude improvements in the energy efficiency and computational speed of edge optimization techniques. A hardware prototype of the concept has demonstrated a 10X reduction in power consumption and a 200X speed improvement compared to conventional MCUs for a solar inverter edge optimization application.

The invention enables fast and efficient edge optimization, and comprises a mixed-signal computing chip programmable through an easy-to-use Python API.



A hardware prototype of the mixed-signal computing system.
Image credit: J. Poon

Stage of Development

- **Prototype**

Applications

- Edge optimization for power and energy systems, including DERs, EV charging infrastructure, and building HVAC equipment
- Examples include but not limited to:
  - autonomous harmonic-minimizing solar inverters
  - optimal decentralized EV charging protocols
  - high-performance predictive motor drives

Advantages

- Enables secure, real-time edge computing and optimization
- Ultra-low power consumption
- Substantially faster compared to conventional MCUs
- Easily programmable through Python API

Publications

- J. Poon, M. Sinha, S. Dhople, J. Rivas, "Real-time Selective Harmonic Minimization using Hybrid Analog/Digital Computing," 2021 IEEE Applied Power Electronics Conference and Exposition (APEC), (Accepted, to appear June 2021).

Innovators

- Jason Poon

Licensing Contact

David Mallin

Licensing Manager, Physical Sciences

Email