NSF Convergence Accelerator

NSF Convergence Accelerator's 2023 Cohort Phase 1 Award

Project Title
Field-Adaptable Chemosensor Solutions with Local Neuromorphic Intelligence

Awardee
Teledyne FLIR Detection

Award/Contract
24C0014

Award Contract Type
R&D

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NSF Funded Program
NSF Convergence Accelerator

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PROJECT ABSTRACT
Sensor responses to chemicals of interest (COI) are constrained by sensor specificity and often obscured by background. These constraints limit the breadth and certainty of analyte detection and render the effective differentiation of COI from background challenging. Contemporary machine learning approaches for analysis of sensor array responses use time-consuming, energy-intensive batch learning methods that train networks on large, fixed datasets. Because expected noise and interference also must be represented in the training set, these approaches can be inflexible, and if they are unable to accurately model these artefacts present in the field, they will yield poor results in practice. In contrast, neuromorphic processors are remarkably energy-efficient, enabling on-device learning and data processing. Moreover, the neuromorphic computing algorithm, Sapinet, supports rapid model training, exhibits continual learning (i.e. new learning does not disrupt the performance of existing learned models), and can identify known analytes despite unpredictable patterns of signal interference arising from environmental background.

We will use Sapinet to evaluate signal features generated by a heterogeneous, leading-edge chemosensor array tuned for the detection of volatile organic chemicals. Peptide-based chemosensors, e.g., those pioneered by Aryballe, offer superior binding/release performance and response diversity across sensors in the array; these features are important for analyte identification and for Sapinet's resistance to unpredictable competitive interference. During Phase 1, we will characterize the properties of the Aryballe array, construct an appropriate Sapinet analysis model using both our Sapicore package and Intel's Lava framework for the Loihi2 neuromorphic processor, and evaluate model performance under realistic conditions. The Phase 2 goal is to produce prototype chemosensory devices developed by Teledyne FLIR, featuring Aryballe peptide chemosensors and Cornell's Sapinet analysis algorithm running on Intel Loihi2 neuromorphic processors instantiated by Georgia Tech.