A Crayfish-inspired Sensor Fusion Platform for Multisensory Integration of Visual, Chemical, and Tactile Information

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The concept of cross-sensor modulation, wherein one sensor modality can influence or modulate another's response, is overlooked in traditional sensor fusion architectures. By neglecting this aspect, valuable opportunities to enhance the accuracy and robustness of the fused data are missed. In contrast, biological systems often exhibit more efficient and synergistic sensor fusion mechanisms. Aquatic animals such as crayfish serve as remarkable models for multisensory integration, skillfully integrating visual, tactile, and chemical cues to evade predators, locate prey, and engage in mating behavior. Inspired by this, we propose a neuromorphic platform that integrates graphene-based chemitransistors, monolayer molybdenum disulfide (MoS_2) based photosensitive memtransistors, and triboelectric tactile sensors to achieve “Super-Additive” responses to weak chemical, visual, and tactile cues and demonstrate contextual response modulation or adaptability, also referred to as “Inverse Effectiveness Effect”. Finally, we use a hypothetical illustration to highlight how crayfish-inspired sensor fusion approach can be transformative for autonomous search vehicles. We hold the view that the concept of bio-inspired sensor fusion can be extended to encompass various sensor modalities, thereby serving a wider array of applications.