Abstract:
Biological Sensor Fusion Inspires Novel System Design

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Sensor Fusion for Identification. Accurate Automation Corporation is developing a biologically-based system architecture, implemented in an advanced technology Multiple Instruction Multiple Data (MIMD) Sensor Fusion Processor™ that provides a breakthrough capability for track-to-track sensor fusion. This architecture also facilitates detecting and fusing weak targets amidst noise.

Biological sensor fusion, which has been extensively studied over the last decade, effectively addresses and provides insight into certain major sensor fusion challenges, including:

- Correlation detections under conditions of poor spatial registry,
- Correlating detections observed at different times,
- Extracting weak signals from noise.

Biological sensor fusion has been found to exist in all vertebrate animals, and appears to be an essential, rather than ancillary, part of sensor data processing. A complex architecture has been discovered and elucidated, which includes multiple interacting systems (e.g. superior colliculus and substantia nigra pars reticulata). Gain control is applied to both eliminate extraneous signal when fusable targets are found, and to maximize signal correlation when the expected signal(s) are not found in the anticipated locations. This can greatly enhance track correlation of moving targets, as well as enhance sensor fusion when the signal of one target is temporally weakened (e.g. due to scintillation). An enhancement of this concept, which we are evolving for later systems, is to use target ID knowledge to influence local system parameters, thus enabling more effective target-specific fusion processing.

We have modeled the biological sensor fusion concept, and obtained results showing extraction of weak signals, even when embedded in a high noise environment. Detailed studies compare fusion results as both S/N and system parameters are verified. Simulation results both confirm and clarify the biological findings.

Based on simulation results, wa are currently developing a novel MIMD neural network processing capability, which is a new product, the Sensor Fusion Processor (SFP™). This real-time fusion processor will be sized to fit into a PCI slot in a personal computer. An ancillary I/O Processor (IOP™) will allow direct connection of the data source or distribution system. This product will implement the biologically-based sensor fusion capability in real-time, and provide greatly enhanced sensor fusion and tracking to support identification environments. Many commercial applications have been identified for the SFP™ and IOP™, including hypersonic aircraft flight control in addition to sensor fusion for combat ID. This work is funded by a Phase II STTR (N00014-95-C-0323) from the Office of Naval Research.

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