
ABSTRACT

Sensor fusion (or multi-sensor data fusion), the combination of multiple data sources to yield an improved estimate of a physical property or value, is employed extensively in the design of measurement devices, autonomous platforms, and instrumentation. Typical small-scale implementations of sensor fusion comprise a primary processing unit (typically a microprocessor or microcontroller) directly interfaced via low-bandwidth peripheral links to a collection of distinct sensor modules in the form of a star or ring network. However, more complex systems—and those employed in physically large or distant platforms—benefit from the distribution of processing nodes and a more-connected network topology utilizing robust error-correcting communications protocols. This thesis assesses typical network and sensor models to develop and evaluate generalized methods and templates for sensor fusion system design that improve task division, resource management, resilience, and latency, thus reducing the impact of inefficient component selection and misconfiguration on sensor fusion calculations and their hardware implementations.

This thesis encompasses three distinct models derived from real-world platforms and applications, covering the domain of sensor fusion applications in contemporary engineered systems. Each composite system model is simulated through all stages of the engineering design process, with evaluation performed on both synthesized and collected data from sample systems and components. Observations made during design and refinement, along with qualitative and quantitative results of sample evaluation, are amalgamated to derive methodologies, guidelines, warnings, and strategies relevant to the engineering design process for real-world sensor fusion systems; the resulting body of information and recommendations serves as a resource for development capable of improving both design efficiency and system performance.