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Editorial

Introduction to special issue on "distributed sensor networks for real-time systems with adaptive configuration"

Sensor integration is concerned with the synergistic use of multiple sources of information. Sensor fusion is a major component of sensor integration, merging multiple inputs with a common representation. There has been an extensive study in the areas of multi-sensor fusion and real-time sensor integration for time-critical sensor readings. A typical setup that is studied is depicted in Fig. 1.

The term "module" is employed instead of sensor to signify that each module has local intelligence, memory, and sensors. Assuming that every sensor has limited accuracy and that a limited number of readings may be arbitrarily faulty, each m_i uses identical logic to deduce the position of object O.

Researchers in sensor data fusion must distinguish between the following fusion levels:

1. Low-level fusion (also called measurement level fusion): fusion is done on the raw data.
2. Medium-level fusion (also called feature-level fusion): some features extracted from raw data are fused.
3. High-level fusion (also called decision-level fusion): decisions are drawn from the data of each separate sensor and these are combined to reach a global decision.
4. Temporal fusion: data from different instances in time are fused.

The development of dynamic distributed networks for information gathering in unstructured environments is receiving a lot of interest, partly because of the availability of new sensor technology that makes them economically feasible to implement. A distributed sensor network is a set of spatially scattered sensors designed to derive appropriate inferences from the information gained. The critical step in this process is the fusion of the data gathered by the various sensors.

It is important to keep the topic of distributive sensor networks in perspective. The recent advances in the sensor technology have led to better and cheaper sensors. These advances beget more complex tactical developments of sensors. Such deployment requires new and sophisticated techniques for information analysis and fusion.

In this special issue on Distributed Sensor Networks for real-time systems with adaptive configuration, we aim to show that there is a wide spectrum of innovative

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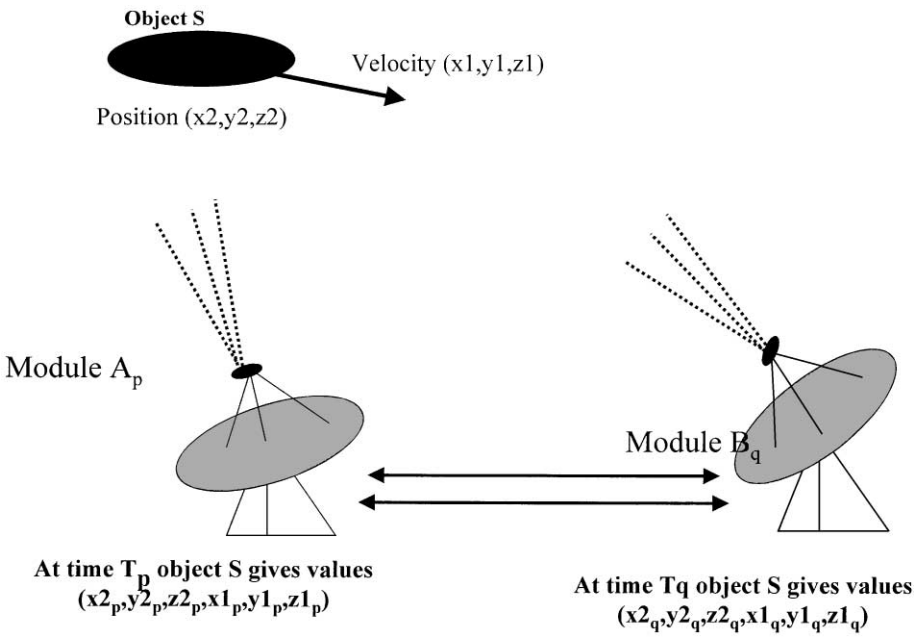

Fig. 1. Modules of m_i and m_j measure the position and velocity of object O.

ideas that have great potential for radical improvements in the distributed sensor networks (DSN) research. This special issue takes a closer look at DSN systems for real-time sensor integration, attempting to separate the hype from the reality, while providing researchers with a number of interesting and relevant directions for further investigation and research. Among the many interesting issues raised by the authors some are mentioned here.

In "Distributed Sensor Networks—A review of recent research", Hairong Qi, S. Sitharama Iyengar and Krishnendu Chakrabarty describe a practical viewpoint of the problem. They provide the architecture of a DSN system from a functionality point of view and deduct the research issues from this stand point. They review and present their research and innovative approaches adopted from four aspects.

1. The network structure design for traditional DSNs and for wireless ad hoc sensor networks (WASNs).
2. The comparison between two data processing paradigms—client/server model and mobile-agent-based DSNs.
3. The sensor fusion algorithm with a performance evaluation among four fault-tolerant interval integration functions.
4. The sensor placement strategy with an application example on target location.

Alois C. Knoll in "Distributed Contract Networks of Sensor Agents with Adaptive Reconfiguration: Modeling, Simulation, Implementation and Experiments"

comparatively explores the performance of multi-level hierarchical networks and flat networks. He also introduces a model of the performance of these types of networks for analyzing the throughput of sensing tasks depending on a variety of network and sensor parameters.

Alvin Lim tackles the problem of self-organizibility in DSNs in "Distributed Services for Information Dissemination in Self-Organizing Sensor Networks". He studies the problem of dynamic query processing, and provides us with three main distributed services: lookup service, composition service and dynamic adaptation service.

"Real-Time Task Scheduling for Energy-aware Embedded Systems" by Vishnu Swaminathan and Krishnendu Chakrabarty presents us with an innovative approach for scheduling workloads containing periodic tasks in real-time systems. Their proposed approach attempts to minimize the total energy consumed by the task set and guarantees the deadline for every periodic task. Their results depict that energy can be conserved in embedded real-time systems using energy-aware task scheduling.

The realization of a practical, smart distributed sensor system requires the synthesis of several technologies. We must bring together the knowledge in the fields of sensor fusion, data and query processing, distributed systems design, and networks. While extensive research has been conducted in all these areas as indicated by the papers compiled in this issue, we hope that this special issue will open a window of opportunity to researchers in the related areas to venture into this emerging and important area of research.

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