Robust Data Modeling in Distributed Sensing Environments using Adaptive Resource Management techniques

Cyber Physical Systems are distributed systems-of-systems that perform reliable data acquisition in order to build efficient data models. Data models are mathematical expressions that describe the attributes of the observed environments. These models can be used for monitoring, tracking and predicting the dynamics of the physical phenomena. Also, data models aid in formulating decision-making procedures under resource constraints. This research covers algorithms to detect and track emergent entities. Also, different techniques to maximize accuracy of tracking will also be discussed.

Data model construction in CPS is challenging because the dynamics of physical environments are hard to track in real-time through a distributed sensing network with limited bandwidth and local memory. Therefore, the limited resources must be optimally utilized to boost performance metrics. Error modeling is an important step in achieving this objective. As a part of this research, accurate models are constructed for different types of errors in the network. These include error due to data loss, communication delay, lack of synchronization and modeling errors. Application goals help in defining the parameters of the cost function. The solution of this cost function is used to decide the resource allocation strategy which reduces one or more of the aforementioned errors.

In the course of this work, two case studies have been explored: Sound-based tracking for vehicular-traffic scenarios and thermal monitoring for 3-Dimensional integrated circuits. Future work includes constructing local models to reduce communication traffic and analyze the effect on network errors and resource allocation strategies. Another aspect is to make the physical models more meaningful by attempting to extract causal relations from the sensor data. This would help in improving the model robustness, thereby enabling the system to respond better to unexpected changes in the dynamics of the physical entities.

Publications:

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