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An Adaptive Sampling Strategy for Real-time Anomaly Detection with Unmanned Sensing Vehicles

Unmanned sensing vehicles (USVs) have been widely used for real-time anomaly detection in various applications, including environmental monitoring, precision agriculture, and military surveillance. The USVs collecting data can only provide partial information about the space being monitored. Thus, it is critical to decide where to deploy the USVs at each point in time to maximize the change detection capability, while minimizing deployment costs. This work proposes an adaptive sampling strategy for real-time anomaly detection with USVs. First, a novel spatio-temporal sequential tensor decomposition algorithm is developed to decompose the high-dimensional data collected by the USVs into three components, a spatial component, a temporal component, and a sparse component, that captures the locations suspicious of change. The spatial and temporal components are used for one-step prediction to guide the adaptive sampling strategy. The strategy is designed to maximize the detection power and control the deployment costs. The main idea is to balance exploration and exploitation by designing a sampling distribution function to decide where to collect data at each acquisition time. The movement of the USVs is controlled by using Voronoi tessellations on the sampling distribution function. The performance of the proposed framework is demonstrated through simulations and case studies.

Keywords

adaptive sampling, online monitoring, spatio-temporal data, tensor completion, unmanned sensing vehicles, Voronoi tessellations

Classification

Both methodology and application

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