Guest Editorial: Foreword to the Special Issue on Graph-Based Localization and Tracking

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The advent of graph-based processing in information fusion has offered a theoretical framework and a comprehensive toolkit for modeling the intricate statistical structures inherent in data fusion problems and has provided efficient and modular algorithmic solutions to high-dimensional problems, creating new benchmarks for performance, scalability, and flexibility. Graph-based methods have rapidly evolved to address the complex challenges of heterogeneous sensing environments, and today, they are at the forefront of pioneering solutions in applications as diverse as autonomous navigation, ocean sciences, asset tracking, future communications, and the burgeoning Internet of Things.

The papers featured in this special issue on *Graph-Based Localization and Tracking* underscore the versatility of graph-based approaches to overcome challenges posed by the non-Gaussian uncertainties of inexpensive, low-power sensing devices, often manifested as missed detections, false positives, and measurements of uncertain origin.

We commence with a paper on multipath-based simultaneous localization and mapping (SLAM), presenting a novel Bayesian particle-based sum-product algorithm (SPA) that can be interpreted as passing messages on a graphical model that adeptly fuses multiple measurements per virtual anchor, enhancing robustness in challenging indoor propagation environments.

Our journey into the underwater realm showcases a graph-based mapping algorithm implemented by autonomous underwater vehicles in mine countermeasure operations. The SPA's application in this domain demonstrates the potential of graph-based Bayesian inference for object detection and estimation in a challenging underwater environment.

We also delve into a comparative study between a traditional Joint Integrated Probabilistic Data Association filter incorporating target-provided measurements and a multitarget tracking approach derived using a probabilistic graphical model. This work provides critical insights into the performance trade-offs in scenarios with closely spaced targets and with targets executing sharp maneuvers.

Lastly, the special issue introduces an integrated learn-then-optimize framework for condition-based predictive maintenance scheduling. This fusion of deep learning and optimization underscores the transformative power of graph-based methods in predictive maintenance models, surpassing traditional methods in ensuring fleet availability and cost-effectiveness.

We invite our readers to immerse themselves in the insights provided by these studies, which shed light on the current state of graph-based localization and tracking and suggest avenues for future research.

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