

Gaussian Process-Based Nonlinear Filtering

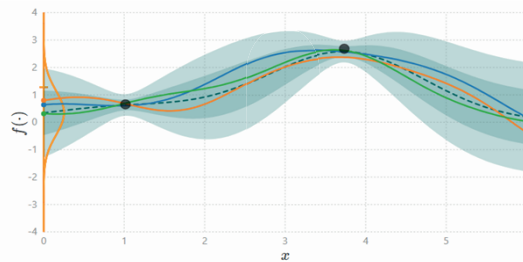


Figure : Visualization for a Gaussian Process (<https://www.infinitecuriosity.org/visgp/>)

Nonlinear state estimation in stochastic dynamical systems remains challenging for classical linear filtering techniques, which often fail to capture complex uncertainty propagation under strong nonlinearities. To address this, the system state belief is represented as a mixture distribution rather than a single Gaussian, enabling a richer and more accurate description of uncertainty.

Gaussian Processes (GPs) provide a non-parametric, probabilistic framework for learning unknown system

dynamics from data while quantifying predictive uncertainty, making them well-suited for such settings.

In this work, the prior belief is discretized into representative samples using an in-house **Projected Cumulative Distribution (PCD)** sampling method. These samples are propagated through a learned transition model, producing probabilistic predictions that are combined into an updated mixture representation of the state belief.

For the measurement update, multiple avenues can be explored, including propagating individual mixture components or using sample-based approximations, followed by reconstruction of the mixture. This ensures a flexible and fully recursive estimation framework.

What to do

- Literature review on nonlinear state estimation
- Transition Modeling using GPs / Neural Networks
- Recursive density propagation
- Integration into a filtering framework
- Evaluation against existing approaches

Requirements:

Background in computer science, mathematics, electrical engineering, mechatronics, or related fields. Interest in probabilistic modeling and nonlinear estimation is beneficial.

Emphasis:

Theoretical Study

Software Implementation

Hardware Implementation

We offer:

- excellent support and advice
- highend infrastructure
- contact to industry and research partners

Language:

English or German

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