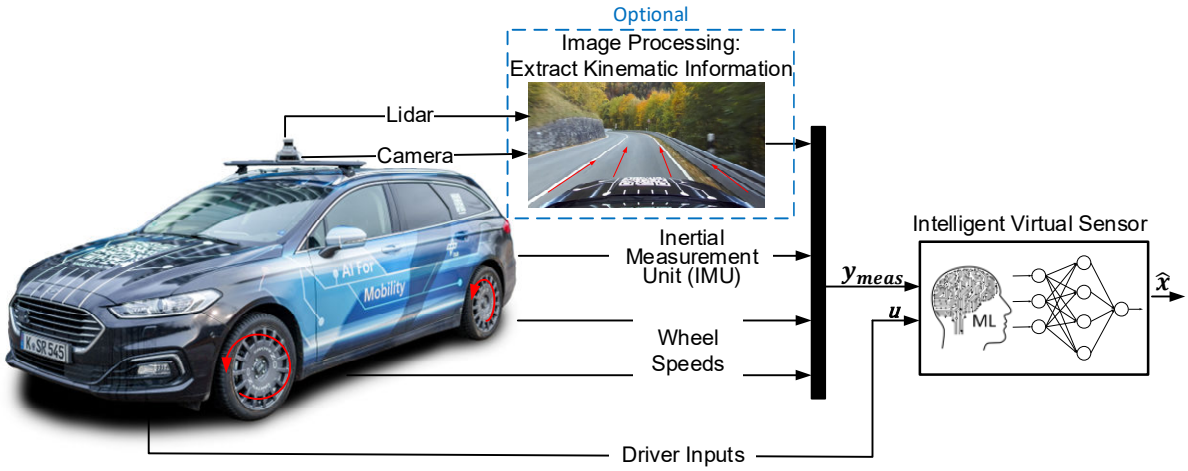
Deutsches Zentrum
DLR für Luft- und Raumfahrt

Proposal for a thesis (Master's):

Investigation of the potential of modern network architectures for vehicle state estimation



Problem Statement:

The Vehicle System Dynamics and Control team at the Institute of Vehicle Concepts is currently developing a new test vehicle that is equipped with a comprehensive sensor system for capturing driving dynamics and environmental sensor data. The development goal is to test innovative methods of state estimation in order to lay the foundation for modern control algorithms.

Accurate state estimation is essential for the development of safe and efficient driver assistance systems and autonomous vehicles. Traditional approaches are based on model-based methods that explicitly map physical relationships. However, these methods require detailed and complex system models, the parameterisation of which is often challenging. Recurrent neural networks (RNNs) such as LSTM and GRU have established themselves as a data-driven alternative, as they can learn temporal dependencies in sensor data such as IMU (inertial measurement unit), GNSS (global navigation satellite system) and wheel speeds directly from the data. Modern architectures such as Transformer and xLSTM show promising characteristics, including improved modelling of long-term dependencies, higher generalisability, potentially better accuracy, and the ability to integrate multimodal data. These advantages have so far been demonstrated primarily in speech processing. However, their potential for state estimation is still largely unexplored

This work aims to compare classic RNNs with modern architectures. The goal is to evaluate their suitability for vehicle estimation. Real world data from the test vehicle is available for the experiments.

Tasks:

- Literature review on state estimation and modern network architectures
- Development and training of suitable novel models and baseline RNNs on existing sensor data
- Investigation of different model architectures
- Documentation of the results
- Optional: Integration of perception data into state estimation

Objectives

- Review of modern network architectures for state estimation in the literature
- Implementation of vehicle state estimators based on modern network architectures
- Comparison of the performance of the trained models

Requirements:

- Good knowledge of machine learning
- Knowledge of control engineering
- Good knowledge of Python

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