Student:	..
Supervisor/s:	Tobias Feigl
Client:	..
Thesis:	Bachelor or Masters Thesis

Generalization of Information to Enable Reliable Data-Driven Information Fusion

Keywords: V2X, Out-of-Distribution (OOD), Novelty detection, Data augmentation, Handling outliers, Domain adaptation.

Motivation. Vehicle to Everything (V2X) communication and 5G connectivity in vehicles enable advanced driver assistance systems (ADAS), collaborative perception, and vehicle platooning. V2X efficiently distributes object data, intentions, and route predictions and recognizes vehicles in situations without direct visual contact, so that future manual or autonomous vehicles can cope with traffic and roads more efficiently and safely. The basis of V2X, the 5G network, enables real-time applications that require high speeds, high availability, low latency, cloud computing, and artificial intelligence. In the cloud, enormous amounts of data are processed by many different sensors of vehicles, infrastructure, and pedestrians, which are shared by the participants, especially the vehicles. Computationally intensive learning algorithms can use these data and pass aggregated results on to the participants in almost real time.

Related work. The state-of-the-art in science and technology suggests a multitude of highly (application and situation) specific and individual solutions for the fusion of information from different sensors and participants [1]. However, since every piece of information depends on its original environment (i.e., source domain), it is unclear how these approaches can be generalized (i.e., adapted) to any sensor family (i.e., unknown target domain), sensor-specific sensor artifacts, different sensor noise, individual sensor bias, measurement intervals, driver behavior, vehicle manufacturers, and urban, rural or motorway environments.

Overall goal. Therefore, the goal of this project is to investigate how different sensor information (source domain) are preprocessed (adapted) in such a way that they flow into the sensor fusion as unspecifically as possible and keep the semantic (i.e., a final network can handle both data from the source and target domain). It is to be checked whether known normalization and standardization procedures are sufficient to bring together different sensors of a family (with different measuring intervals and scales) and different sensor families: a) different sensors in one family; b) different sensor families; c) different sensors and sensor families. And the student will investigate state-of-the-art domain adaptation mechanics that may also be employed on unlabeled or noise labeled data. [1]

Timetable (6 months, in person weeks [PW]).

4PW Literature and patent research; Familiarization with relevant work on the subject areas. [1]

4PW Adaptation of the individual components.

6PW Methodological work.

4PW Evaluation and real-world demonstration.

6PW Transcript.

Expected results and scientific contributions.

- Domain adaptation: A general pre-processing step, e.g., a neural network, that normalizes the various input data streams, such that the data are robust to different sensor scales, delays, gaps, and sampling frequencies.
- A localization pipeline that is real-world applicable and supports or replaces state-of-the-art Kalman Filter. The real-world applicability is given by a live demonstrator.
- The sensor information streams should consist of data such as Time-of-Arrival (ToA), Position, and inertial measurements (gyroscope, acceleration, and magnetometer).
- ToA or position values will be collected for different motion dynamics and different propagation scenarios.
- The pipeline will be implemented in python with support from pytorch scipy, and scikit.learn.

References

[1] Shiqi Yang, Yaxing Wang, Joost van de Weijer, Luis Herranz, Shangling Jui. (2021). Generalized Source-free Domain Adaptation. arXiv:2108.01614 [cs.CV]