Data Augmentation in the Latent Space for Boosting Performance on Radar-Based Presence Sensing Applications

Master's Thesis

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Context

Radar for indoor monitoring is an emerging area of research and development, covering and supporting different health and wellbeing applications of smart homes, assisted living, and medical diagnosis. The important properties of safety, reliability, low power, preservation of privacy, and insensitivity to light have expanded radar applications from open terrain target detection, classification, and localization to human motion recognition inside buildings and enclosed structures. The principal objective remains to achieve a high probability of detection and low false alarm rates. Deep neural networks (DNNs) have shown great potential as a preferred classification choice for radar based applications. However, a common challenge in radar-based human presence recognition is how to deal with the limitations of small datasets. Researchers have attempted to overcome this challenge by data augmentation, where the available radar data is modified. The augmentation methods are usually manually designed and carefully evaluated for each data type separately, like image processing functions for image data. Most of these augmentation techniques are not applicable to radar data. In addition, radar applications work based on a combination of raw signals and preprocessed images. Therefore, we need an automated data augmentation approach to augment data for any modality in a generic way [2].

Goal

In this thesis, we aim to exploit automated data augmentation in the latent space to adapt the transformation to data of different types [1]. Through comprehensive experiments, we will demonstrate the effectiveness of this technique in improving the robustness of the presence sensing classification and in outlier detection [3].

Working Plan

1. Get familiar with the radar-based presence detection application provided by Infineon
2. Identify state-of-the-art techniques in domain agnostic data augmentation and latent space data augmentation
3. Prepare a list of possible solutions for the given application
4. Implement the necessary modules to run experiments and statistical validation
5. Measure the performance of the controlled experimentation framework
6. Write the thesis

Deliverables

- Source code of the implementation preferably deployed in Docker
- Technical report with comprehensive documentation of the implementation, i.e. design decision, architecture description, API description, and usage instructions.
- Final thesis report written in conformance with the respective university guidelines.

References

[1] Tsz-Him Cheung and Dit-Yan Yeung. "Modals: Modality-agnostic automated data augmentation in the latent space". In: *International Conference on Learning Representations*. 2020.

[2] Terrance DeVries and Graham W Taylor. "Dataset augmentation in feature space". In: *arXiv preprint arXiv:1702.05538* (2017).

[3] Xuefeng Du et al. "VOS: Learning What You Don't Know by Virtual Outlier Synthesis". In: *arXiv preprint arXiv:2202.01197* (2022).