**Institut für Industrielle Informationstechnik**
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# Masterarbeit

# Closed-Loop Data Synthesis for Long-Tail Detection

## Description

Build a closed-loop data synthesis pipeline where a detector provides feedback to a generator (Latent Diffusion + ControlNet) so that synthetic samples target the weaknesses of the detector for long-tail classes. You will implement iterative cycles of generation, automated filtering, selective inclusion and retraining, and quantify the fidelity-vs-diversity trade-off and hallucination risk. The project combines generative modeling, active learning and robust evaluation to produce actionable guidelines for safe and effective synthetic augmentation.

## Tasks:

1. Implement a generation pipeline using Stable Diffusion / latent diffusion and ControlNet for context-aware object placement.
2. Train a baseline detector (YOLOv11, RT-DETR) on real dataset subsets and identify underperforming long-tail classes.
3. Design a feedback mechanism where detector uncertainty, false-negative proxies and diversity metrics guide prompt/conditioning optimization.
4. Implement automated quality filters (CLIP-consistency, detection-consistency) and human spot checks to control hallucinations.
5. Run iterative cycles (generate -> filter -> add -> retrain), sweep synthetic mixing ratios and evaluate mAP, per-class AP, FID, CLIP-score and hallucination rates.

The work can be done in German or English.

## Prior knowledge

- Generative Models (Diffusion, Latent Diffusion)
- Object Detection training (YOLO, RT-DETR)
- Strong interest in and enthusiasm for research

## Research area

- Generative AI for Computer Vision
- Long-Tail Object Detection
- Closed-Loop/Feedback-driven Learning (C
- Synthetic Data Generation
- Uncertainty Estimation

## Studiengang

- [x] Elektro- und Informationstechnik
- [x] Informatik
- [x] Mathematik
- [x] Physik

## Alignment

- [x] Research
- [x] Implementation
- [x] Analysis and evaluation
- [x] Method development

## Start

At any time

## Links

Mitarbeiterseite

## Ansprechpartner

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