

Hamburg, 22.04.2023

Master-/ Project thesis at the Institute of Logistics Engineering

Title: Utilizing Generative AI for Synthetic Data Generation in Computer Vision Testing

The commercial fruit cultivation field along the southern banks of the Elbe River in Hamburg and Lower Saxony is the second-largest contiguous fruit-growing area in Europe. In this context, the SAMSON Project was initialized to support farmers in the sustainable management of orchard areas through AI-powered automation systems.

One of the key objectives of the project is the automated detection of apples and blossoms to predict the yield after harvest. Data labeling for related supervised machine learning topics is crucial for model performance and accuracy, as it directly influences the quality of the training data. However, creating sophisticated labels is time-consuming and resource-intensive, requiring significant expertise and manual effort. A promising solution involves the use of synthetic data to create a virtual representation of the physical environment. One way of synthetic data generation is the utilization of Generative AI, where images of specific objects or scenes are created by machine learning algorithms to mimic the real-world samples provided by camera sensors. This approach ensures that the position of each object is already known, which opens the potential to automatically annotate large amount of data.

To summarize: The main goal of this work is to investigate the potential of generative AI in creating realistic synthetic data of variety specific apples on trees. In the subsequent phase, the self-annotated synthesized data will be employed to train object detection and tracking algorithms, which will then be compared with gathered field data from RGB-cameras.

Task definition:

- **State of the Art Review:** Comprehensive analysis of the latest advancements in Generative AI algorithms to automatically create annotations in images.
- **Implementation of the Algorithms:** Data sample collection and Training of the machine learning model to mimic the input images in terms of appearance and, if necessary, object placement.
- **Data evaluation and analysis:** Evaluation of the usage of Generative AI to generate synthetic in comparison to the physical captured data via camera hardware systems.

Requirements:

- Students of engineering or computer science
- Experience with Python and PyTorch
- Prior experience with digital twins is welcomed but not mandatory