Toward a Procedural Fruit Tree Rendering Framework for Image Analysis

Thomas Duboudin, Maxime Petit, Sridhar Ragupathi, Liming Chen

{first.last}@ec-lyon.fr ~ liris.cnrs.fr/**imagine**

Motivations & Objectives

- No large-scale real images dataset publicly available in robotics for fruits harvesting. Only a few synthetic specialized datasets [1], with low reusability.
- Modern image analysis methods (*e.g.* image segmentation) often rely on deep learning and yield great results, provided enough data is available.
- Our objective : create a fruit tree rendering framework able to generate datasets quickly, with a high diversity of images and a maximum reusability (inspired by [2]).

Material and Methods

- **Software**: Blender - an open-source 3D modelling and rendering software with a complete Python API (every parameters can be reached through the API). This allows for an easy procedural and randomized generation of a large amount of data.
- **Ressources**: We use freely available textures (for the leaves, for instance) and 3D models (for the fruits), to allow for an easy reuse of our work.
- **Method**: There is a 2-steps generation process :
  - **(1)** The scene is generated, in which the **scene parameters** (chosen randomly or manually) are fixed. They are fixed for the rendering duration because changing these parameters for every image would greatly slow down the rendering process.
  - **(2)** The rendering loop starts. Each step in the loop does the following : update the **rendering parameters** randomly and render an image based on these new parameters. The labels are rendered with the images.
- **Variations**: The framework enable variations and randomization (as it was proven effective by [3] when using synthetic data) in several aspects :

Scene parameters
Tree architecture
Type of fruits
Sizes and shapes of fruits
Sizes and shapes of leaves
Fruits and leaves textures
Position and number of fruits
Position and number of leaves
Type of labels wanted

Rendering parameters
Camera point of view
Background image
Lightning conditions
Rendering quality

- **Rendering**: **less than 30 seconds** for one pair of image and its corresponding label (512x512 pixels) using GPU-rendering (on a NVIDIA GTX 1080)

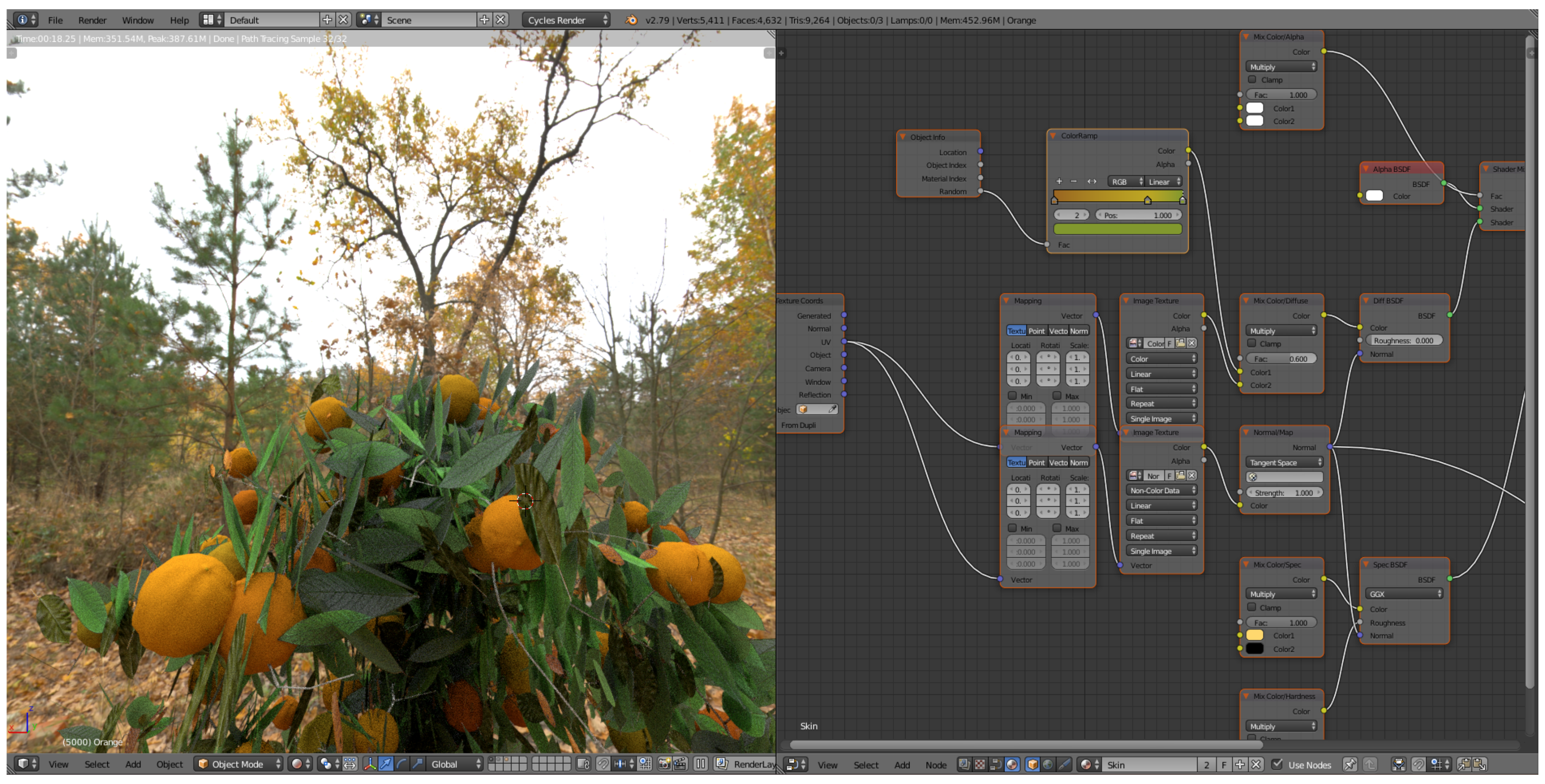

Figure 1: Overview of Blender GUI with the rendering (left) and the nodes of one orange (right). The nodes control textures and material properties (*e.g.* colors and shaders) of the object. It is automatically produced from the scene generation Python script.

Results

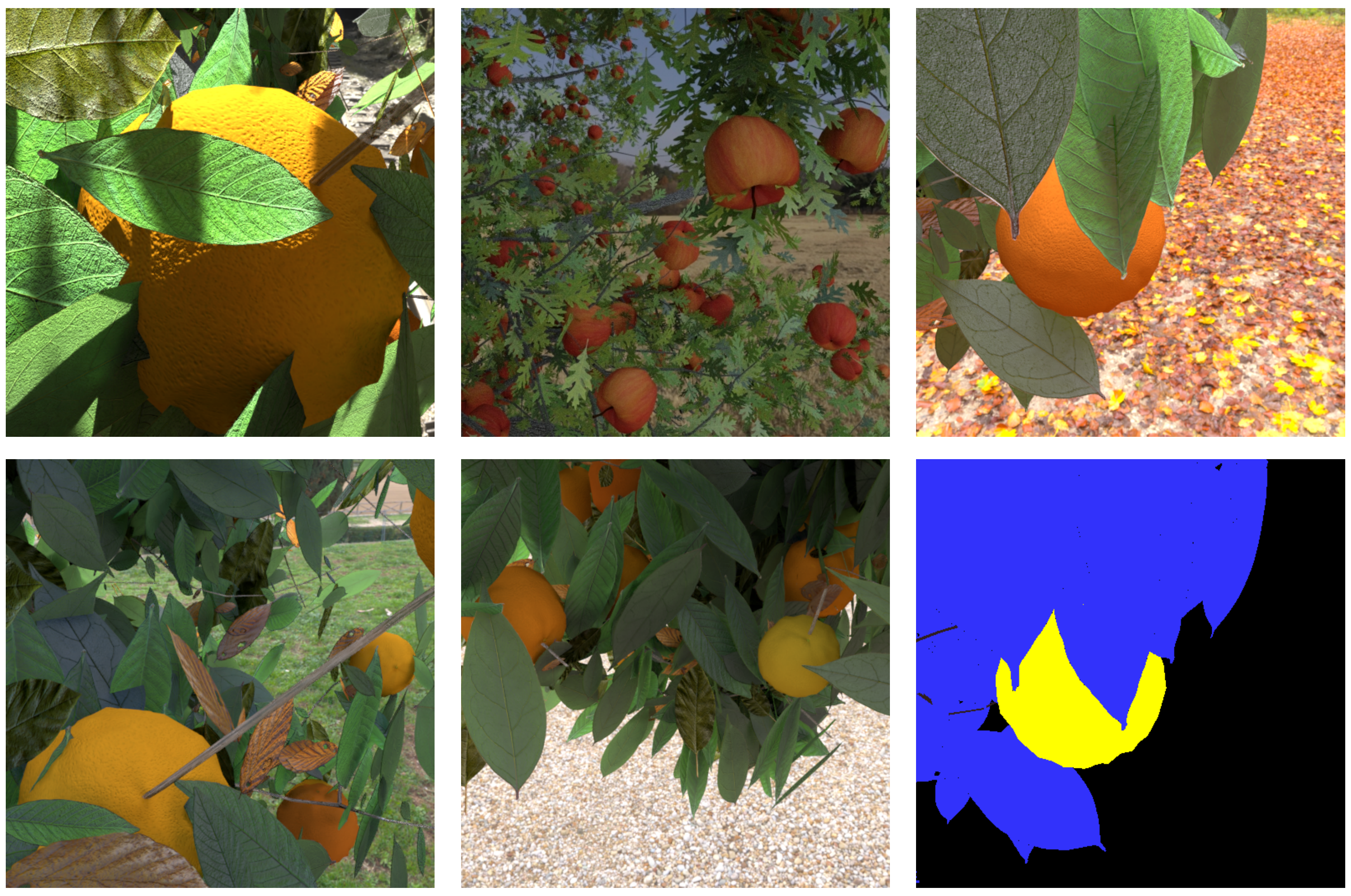

Figure 2: Samples of synthetic oranges and apples (middle top) with different points of view and background. On the right is a rendered RGB image and its corresponding semantic segmentation map below.

Conclusion and Future Work

- **Source code available here :** https://github.com/tduboudi/IAMPS2019-Procedural-Fruit-Tree-Rendering-Framework
- **Can be used to generate around 10k images in one day for your personalized computer vision task related to fruits harvesting.**
- **Future Work**:
  - **Use of domain adaptation methods to reduce the performance drop of a model trained on synthetic data and applied to real data (such as in [4])**
  - **Improvements over the current framework with a main objective : to increase the reusability of the framework and to make it easier to introduce variations in the generated data.**

[1] R. Barth, J. IJsselmuiden, J. Hemming, and E. J. Van Henten, "Data synthesis methods for semantic segmentation in agriculture: A capsicum annuum dataset," *Computers and electronics in agriculture*, vol. 144, pp. 284–296, 2018.

[2] A. Depierre, E. Dellandréa, and L. Chen, "Jacquard: A large scale dataset for robotic grasp detection," in *IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS)*, 2018, pp. 3511–3516.

[3] J. Tobin, R. Fong, A. Ray, J. Schneider, W. Zaremba, and P. Abbeel, "Domain randomization for transferring deep neural networks from simulation to the real world," in *IEEE IROS*, 2017, pp. 23–30.

[4] R. Barth, J. IJsselmuiden, J. Hemming, and E. van Henten, "Optimising realism of synthetic agricultural images using cycle generative adversarial networks," in *IEEE IROS workshop on Agricultural Robotics*, 2017, pp. 18–22.