Master's Thesis Engineering Technology

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Synthetic data generation via Blender for training object detection networks: evaluation on apple detection in orchards

Senne Colson

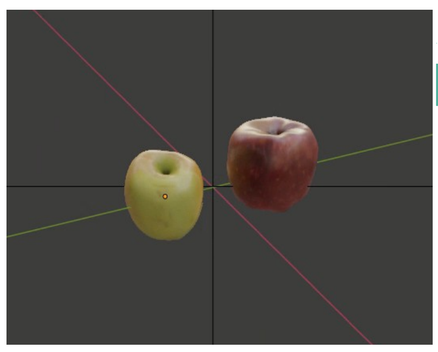
Master of Electronics and ICT Engineering Technology

INTRODUCTION

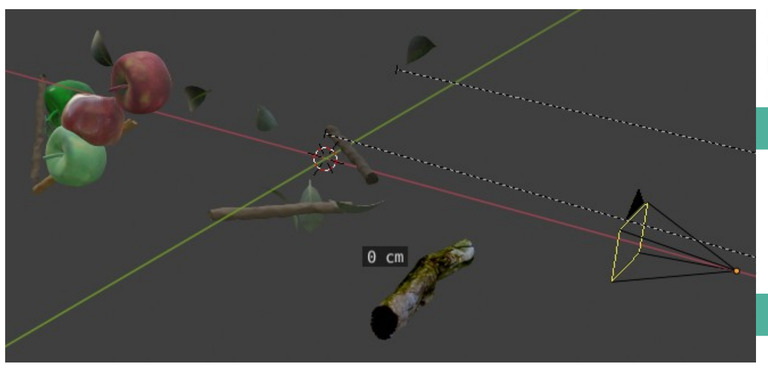
A big obstacle when training a neural network is the large amount of ground truth necessary. This master's thesis explores the possibility to solve this problem by generating synthetic images via Blender. Afterwards, this method will be used and evaluated by detecting apples in an orchard via Mask Region based Convolutional Neural Network (Mask R-CNN). In the future this method can be applied to detect fire blight in orchards.

METHOD

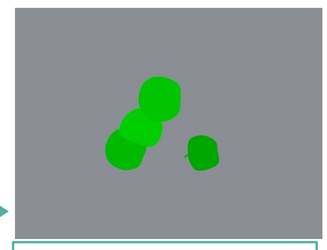
Data generation (Python3 + Blender)



- Multiply
- Randomize:
  - Shape
  - Texture
  - Position
  - Rotation
- Add obstacles



Change textures to color, hide obstacle (branches and leaves) and sun and render



Ground truth image

Render everything

Synthetic image

Mask R-CNN and evaluation (Python3 + COCO)

Ground truth image

= pixel-wise labeled synthetic images

COCO-format:
info; licences; images; annotations; categories

Mask R-CNN (transfer learning)
- ResNet 101
- Region proposal network
- RoI classifier
- CNN for segmentation masks

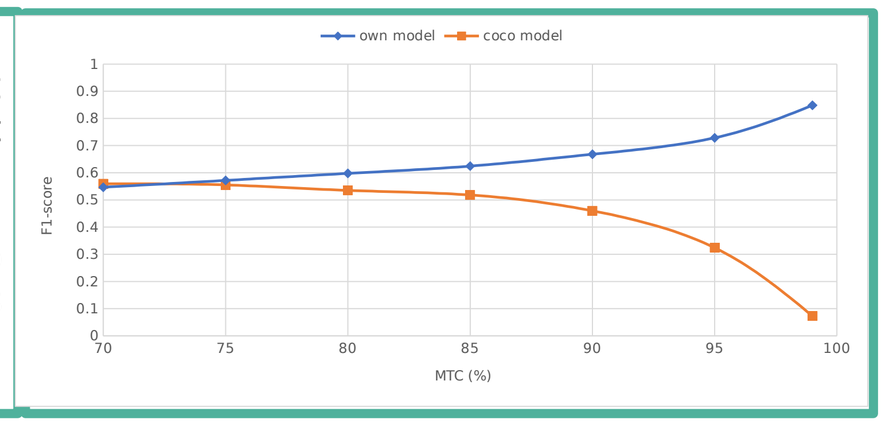
Detection of apples in real image via own model (confidence > 0.95)

VS.

Detection of apples in real image via model trained by standard COCO-dataset (confidence > 0.95)

RESULTS

The program in Blender is able to generate synthetic images of any object with obstacles alongside with its ground truth. However, it takes about three seconds per image. Additionally, this data was used to train a CNN and evaluate it by detecting apples in an orchard. Whit an F1-score of 0.85 and detection confidence of 99%, there were a few false positives, but no real false negatives were observed. In the environment of an orchard, this is a big improvement from the COCO model.



CONCLUSION & FUTURE WORK

During this master's thesis, a framework was built in order to generate a big dataset (of 2750 images, in this master's thesis) without the necessity to annotate any image. Using this framework, a model was successfully trained to detect apples in an orchard.
Thus far, there are a few false positives. In the future, this could be solved by adding random objects in the train images.

Internal Supervisor/ Cosupervisor: Prof. Dr. Ir. Eric Demeester, Ing. Bart Moyaers

External Supervisor: Dr. Ir. Serge Remy

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