RGBD Apple Detection in Mock Orchards Dataset Using Yolov5

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Introduction

- Drones are mostly being used for birds-eye view observation.
- By attaching a robotic arm on a drone, we can enable it see and hence to touch or grab objects in its surroundings.
- In this study we collect a dataset of RGBD images of hanging apples, mimicking an apple orchards.
- We train Yolov5 object detector to detect apples in these images.

Materials and Methods

- Custom made dataset: Mini-Orchard Dataset
  - Consists of RGBD-images: RGB (Figure 2) and Depth (Figure 3).
  - Apple orchard
- Detecting objects using YOLOv5s
  - By detecting objects in the RGBD images the 3D position of these objects can be generated.

Abstract

Attaching a robotic arm on a drone and for inspecting apples in an orchard is proposed to be done autonomous. To make this autonomous a detection model needs data. Can a mock RGBD data be used to localize apples in orchards? The following steps were taken to investigate whether this approach is a step in the right direction: collecting data, training the YOLOv5s model on this data, compare different approaches on YOLOv5s and localize the objects in this data with the best model for this purpose. The different approaches on using YOLOv5 were able to achieve equal mAP values. By using tiled YOLOv5s an accurate localization of the detected objects was achieved with a mAP of 90.9% on object detection. This concludes that simulated data can be used for this purpose. The next step is to examine how the simulated data performs on a real situation. And eventually have a drone fly towards the apples it is detecting.

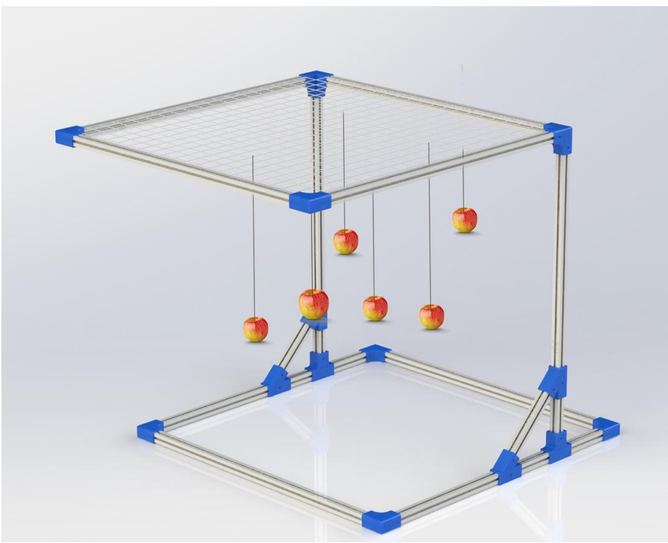

Figure 1. Setup used to create Mini-Orchard Dataset.

Materials and Methods

Figure 2. Depth layer captured by Stereo camera.

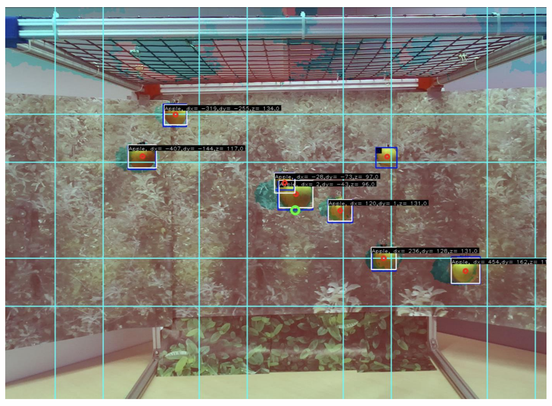

Figure 3. RGBD image, RGB image and Depth layer stacked.

Experiments and Results: Comparison

- Comparison between YOLOv5s with different augmentations and features
  - RGBD / RGB
  - Tiled / Resized YOLOv5
  - Features: Random Positive Tiling/ Random Tiling
- Results:
  - The mAP values of all the models come down to 90.9%.
  - All models can perform equally.

Mini-Orchard Dataset

Method/ Datatype	Precision	Recall	F1 score	mAP
Resized/RGBD	**99.1%**	98.3%	98.7%	**90.9%**
Tiled/RGBD*	98.4%	97.8%	98.1%	**90.9%**
Resized/RGB	98.8%	98.6%	98.7%	**90.9%**
Tiled/RGB	98.3%	**99.1%**	98.7%	**90.9%**

Table 1. These results are displayed from a 0.5 threshold. mAP gives the overall performance.
* Has Random Tiling feature instead of Random Positive Tiling

Experiments and Results: XYZ Locations

- Goal: Retrieve XYZ locations of detected objects in relation to the center of the image.
  - By using the YOLOv5s Tiled model
  - RGBD images
- Results: By using the depth value of the Depth Layer the distance to the camera can be added to the apples information

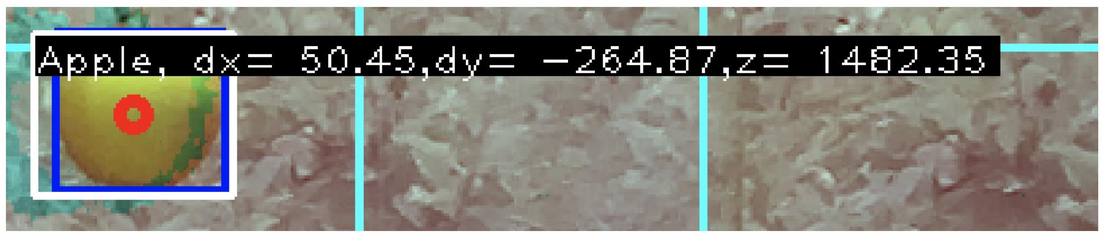

Figure 4. Detected bounding box(white) with dx, dy and z in mm

Conclusions

- The YOLOv5s Model can perform equally on all different approaches.
- If model performance needs to be improved, the models should be trained with more difficult data. So, it is able to detect apples in more difficult situations. Such as apples obstructed by leaves or other apples.
- By using RGBD Images it can generate the dx, dy and z in mm for all the detected apples. This is all calculated from the center of the camera.
- This research is also applicable for other situations. It does not have to be for a drone and apples as objects. It is far broader than that.

References

[1] Andreas Claesson, Anders B¨ackman, Mattias Ringh, Leif Svensson, Per Nordberg, Therese Dj¨arv, and Jacob Hollenberg. Time to Delivery of an Automated External Defibrillator Using a Drone for Simulated Out-of-Hospital Cardiac Arrests vs Emergency Medical Services. volume 317, pages 2332–2334, 06 2017.
[2] DJI. Dji drone rescue map. site=https://enterprise.dji.com/drone-rescue-map, organization=DJI, 2022.
[3] Lidar-based semantic perception for autonomous vehicles.
[4] Alberto Broggi. A closer look at lidar and sterovision. site=https://www.ambarella.com/blog/a-closer-look-at-lidar-and-stereovision/,organization=Ambrella International LP, 2020.
[5] Zhangyi Chen, Xiaoling Li, Long Wang, Yueyang Shi, Zhipeng Sun, and Wei Sun. An object detection and localization method based on improved yolov5 for the teleoperated robot. volume 12, 2022.

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