Expected Agrosense Generation 2.0

1. The sections we want to modify/add in this generation
   1. All the options need to be real-time
   2. Hardware

Sometimes the images come from the upper camera and the down camera cannot be synchronized.

Improve the image resolution for fruit detection.

…

* 1. Tree trunk detection

The grass on the ground will block the tree truck, which will cause the detected bounding box to be shorter than the actual.

Some trees have lusher leaves that will block the tree truck, making the tree trunk hard to detect.

Lush shade blocks the light, making the trunks dark and hard to see.

Leaning tree trunks are also difficult to detect. We need to enrich the diversity of the training set.

* 1. Tree counting

Because of the reason mentioned before, some trunks cannot be detected, making them unable to be counted.

Once detected, the tracking accuracy should be 100%.

* 1. Tree height estimation.

Use the bottom point of the bounding box and the height point of the tree to estimate the tree height, the bottom point might not be the lowest point of the tree (as there are grasses).

Use the soil average height as the lowest point, because of the shade, the RealSense depth value will be bigger than the actual.

After modification, the final accuracy is expected to be above 95%.

* 1. Tree density classification

We need more data as the training set. The ground truth is too objective. Still only have 3 classes: low, medium, high.

* 1. Fruit counting

The immature fruits are green, which is hard to distinguish from the leaves.

The amount of fruit is large, and fruits can hide behind the leaves.

The fruit is small, which needs a high resolution of the images and brings difficulty to object detection. Also, time-consuming for data labeling.

* 1. Health diagnosis (optional)

Classify the tree healthy level: healthy, ordinary, sick. Might depend on the density.

1. Hardware platform design

Base platform: A truck with a trailer. Cameras and processors will be mounted on the trailer.

Processor: One or more Jetson Xavier/ Jetson AGX Orin, or one laptop.

Camera: Four RealSense D435i

1. Ideal methods for sections.
   1. real-time

Use lightweight algorithms or improve the hardware capability.

* 1. Hardware

Try to connect one jetson with one camera, or one jetson with two cameras, to improve the data transmission speed. Or use a laptop with better data transmission and processing capabilities.

* 1. Detection

Grass: Use depth information to filter the object that is too close to the camera. The training bounding box can be larger, including the Y-shaped tree trunk as one of the features, and ignore the grass at the bottom.

Lusher leaves: add another class: canopy. When the tree trunk is completely behind the leaves, select the canopy as the detection feature. Or using the view when the tree trunk is not in the middle

Shade: use image processing method as pre-processing, making tree trunk obvious.

The baseline is considered to be YOLOv8 so far. To improve the speed, consider using pruning-YOLOv8, and TensorRT acceleration on Jetson.

* 1. Tree counting

The tree trunk might not be detected in the middle but might be detected in other frames.

* 1. Height estimation

When using the soil average as the bottom height, eliminate the shadow area.

* 1. Fruit counting

For the hidden fruit, use multi-view to count. Consider adding an infrared sensor or temperature sensor for an infrared image or heat map, as the fruit in different growing stages should have different refractive.