



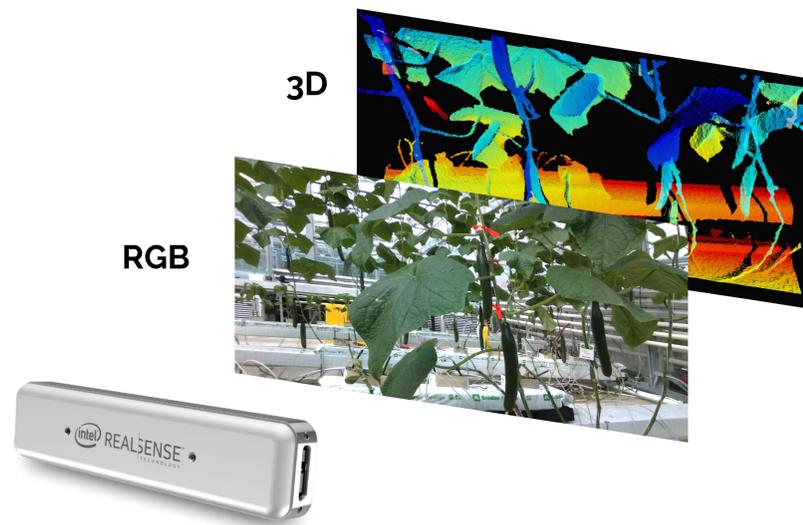
# Computer Vision for Horticulture Robotics

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## Cucumber vision system

We apply computer vision to identify target locations for a robotic harvesting system. Images and 3D scan data are analyzed with a deep learning model to detect fruit, characterize ripeness and localize them in space. Information is then passed to a robotics system for tracking and harvesting.



**Figure 1:** The Intel RealSense D435 gives us our RGB image with a registered point-cloud.

The computer vision algorithms based on deep learning are trained using a set of manually annotated images and corresponding 3D data. The overall software architecture is modular so it can be adapted for use with other crops as well.

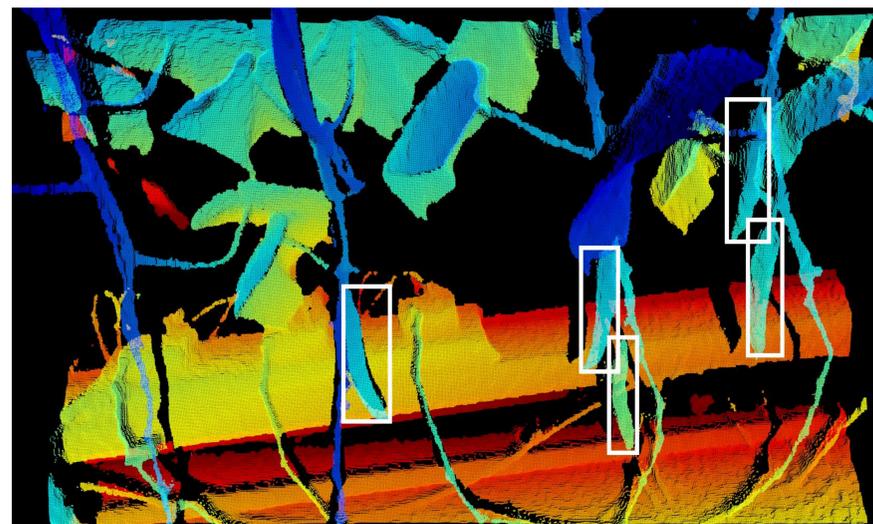
## Detection and localization

A trained deep learning model architecture is used in combination with image processing techniques to detect cucumber fruit in the RGB (colour) image. Unreachable fruit are removed based on constraints extracted from the 3D data.



**Figure 2:** Image segmentation results overlaid with the RGB image.

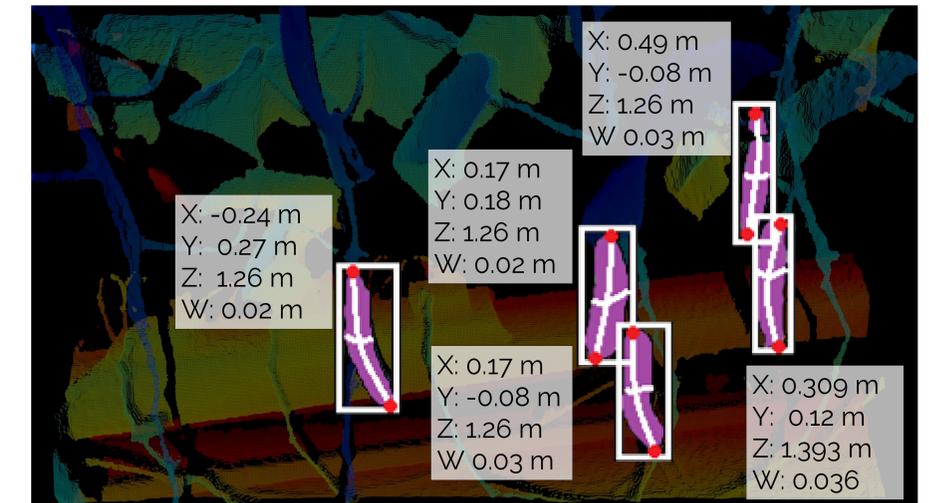
Using the 3D information, we then determine the location of each fruit in space for use in robotic harvesting actions.



**Figure 3:** Localization of 3D points (dark green) in the point-cloud data. The black bounding boxes provide rough information regarding location and size of the fruits.

## Characterization

Using the extracted 3D information for each fruit, we then derive useful characterization information such as top, bottom, width and curvature of the cucumbers.



**Figure 4:** Characterization results: the text boxes contain the bottom location of each cucumber, the red lines are 3D splines fitted to the point-cloud.

Follow this QR code or click the hyperlink below to see a video demonstrating the fruit detection algorithm:

<https://youtu.be/oUsfyatfEGg>



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