Learning to harvest new fruits

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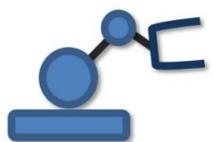
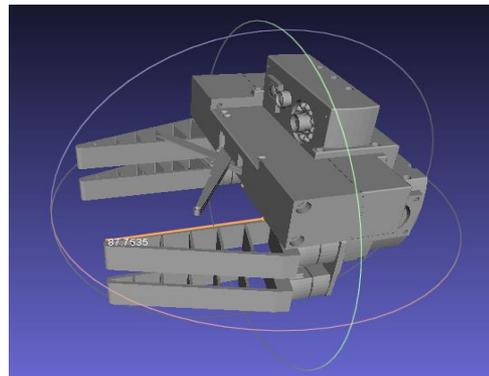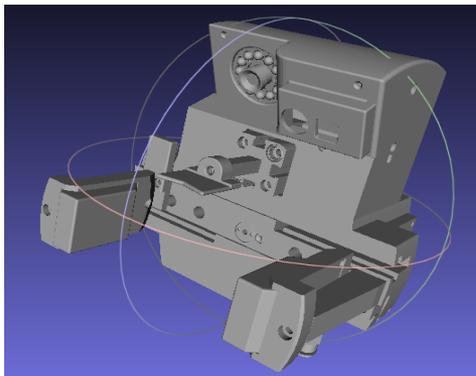# Flow chart for grasp learning of new fruits
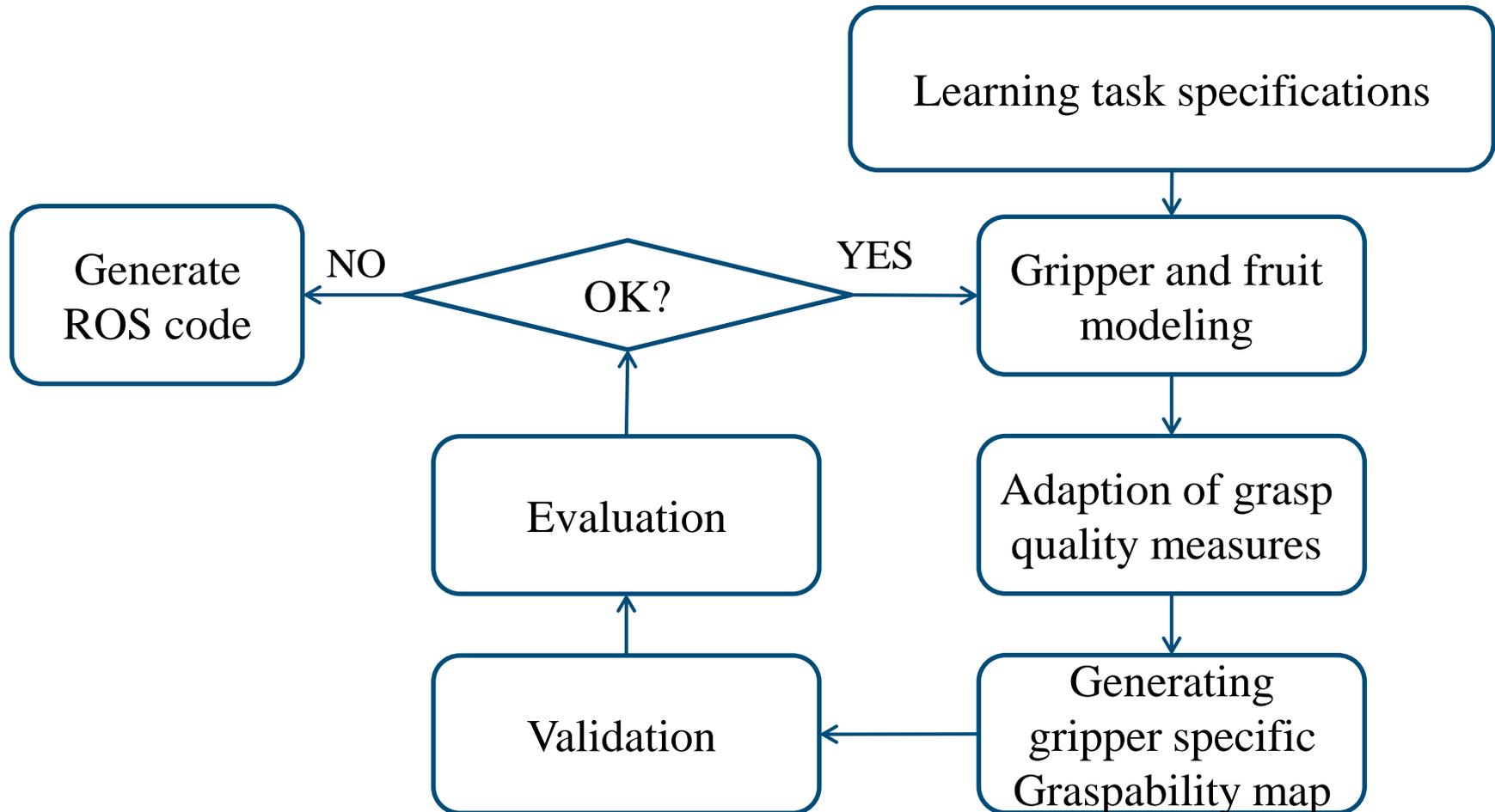
Stage 1 – Learning the task specifications

- Different fruits may have different grasp requirements: approach directions, contact point, allowable force, gripper mechanics, etc.

- Examples of differences between appels and peppers:
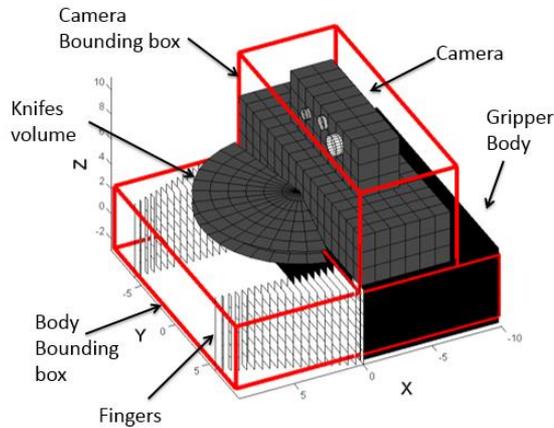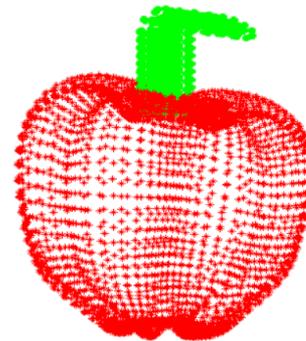
Human

Robot

Stage 2 – Gripper and fruit modeling

- The graspability map is gripper and fruit dependent. Thus models of the fruit and gripper are required. Fruit model should include size variation information.

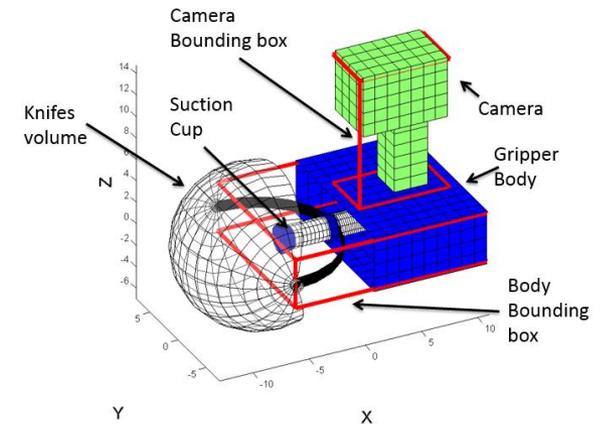- Examples of two different grippers for pepper harvesting and a pepper, all modeled in MATLAB.

## 2 Finger + knife gripper

Pepper

Suction + Basket gripper

- The grasp quality measures might be different due to different task requirements, e.g., apples are harvested using shear force while peppers are harvested using a knife.

- Example grasp quality measures for apple harvesting, suitable 3D point cloud data obtained from real sensors. Pepper harvesting required in addition a enforcing parallel approach and testing knife intersection with fruit.
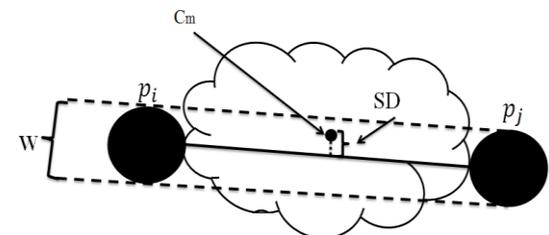
Force Closure Angle

$$FCA = \begin{cases} \dfrac{\vartheta - \max[\theta_j, \theta_i]}{\vartheta} & \theta_i, \theta_j < \vartheta \\ 0 & else \end{cases}$$

Stability Distance
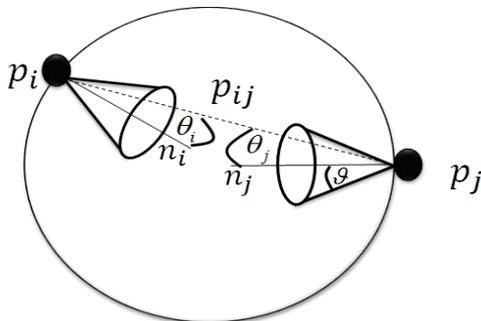
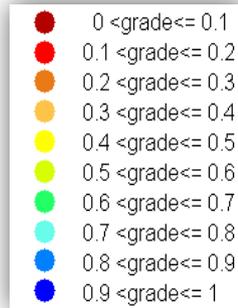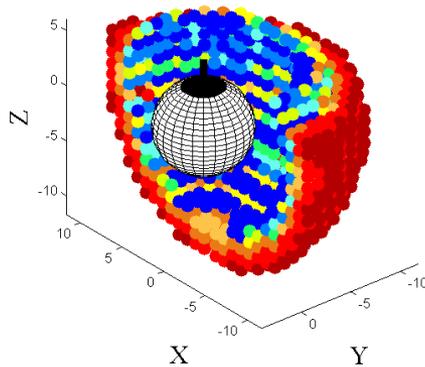$$SDW = \begin{cases} \dfrac{abs(W/2 - SD)}{W/2} & SD \leq W/2 \\ 0 & else \end{cases};$$

$$SDL_{MAX} = \dfrac{abs(L_{max}/2 - SD)}{L_{max}/2}$$
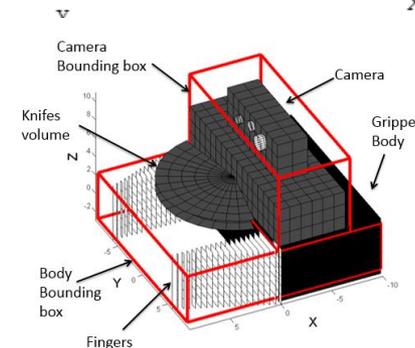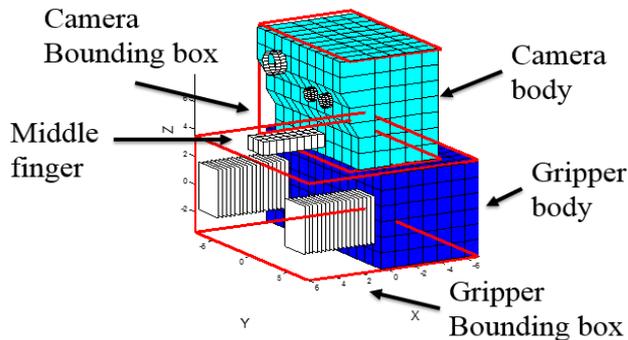

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Stage 4 – Gripper specific Graspability map

■ Examples of graspability maps for an apple and a pepper. Where the pepper has less grasps due to the need for cutting the stem at a specific area.

Apple graspability

Pepper graspability

●	0 <grade<= 0.1
●	0.1 <grade<= 0.2
●	0.2 <grade<= 0.3
●	0.3 <grade<= 0.4
●	0.4 <grade<= 0.5
●	0.5 <grade<= 0.6
●	0.6 <grade<= 0.7
●	0.7 <grade<= 0.8
●	0.8 <grade<= 0.9
●	0.9 <grade<= 1
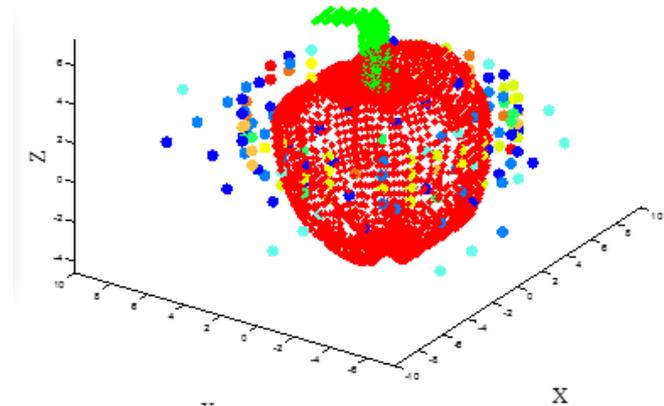
Stage 5 – Validation

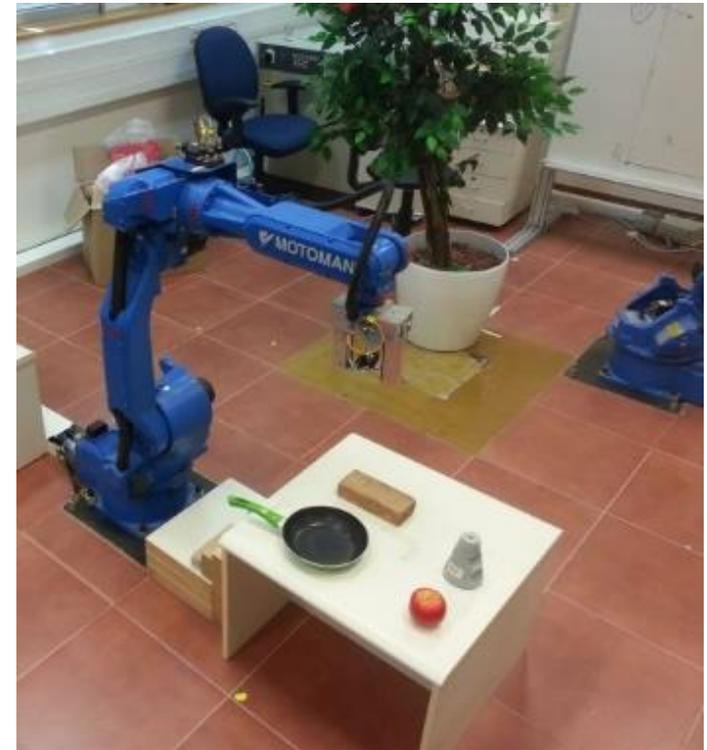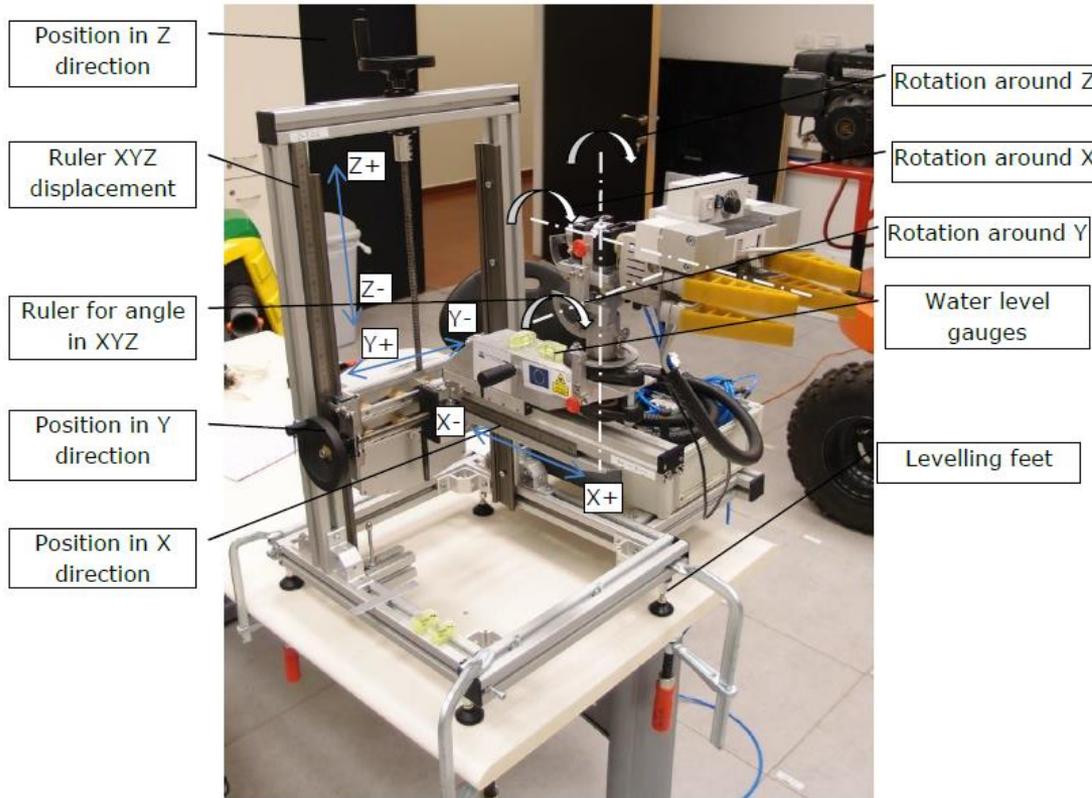- Examples of experiments conducted for the validation of different graspability maps with different grippers in the laboratory.

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- The evaluation stage includes testing and comparing the developed grippers, and can also be integrated with other steps such as collision detection.

- In the example, 15 peppers, each haveup to 9 possible grasps.

The grasps are sorted by their distance from the trellises. If the gripper collides with a trellis or a near by fruit during the grasp execution than it was disqualified.
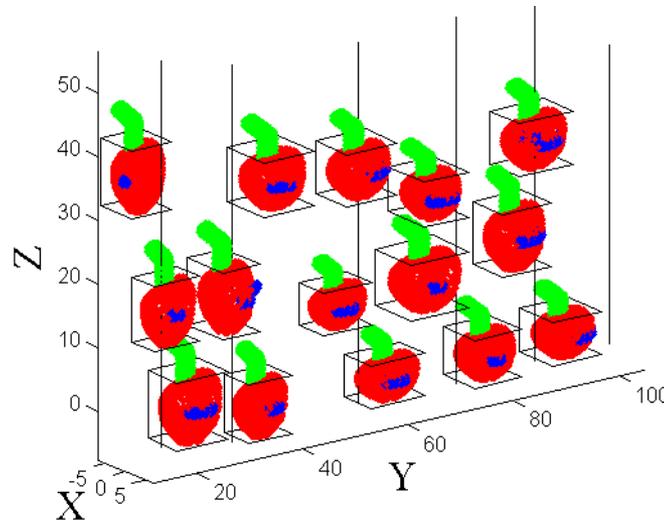
Stage 7 – ROS Nodes

- The input nodes which effect grasp planning are: Fused fruit and Stem Detection.

The nodes which should be further updated are:

- **Node1 name**: grasp_planning
  - **Description**: Selects which fruit to pick and where to pick it, includes collision detection between the gripper, the fruit and the trellises.
  - **Subscribed topics:** /Fused_Fruits/fruits_detected. Position and orientation of the fruit
  - **Published topics:** /Fruit_Affordance. Topic includes nine targets for all of the fruits (position and orientation).

- **Node2 name**: Task_Planning
  - **Node description**: Ranks the fruits according to their height (top to bottom).
  - **Subscribed topics:** Fruit_Affordance