Autonomous 3D model generation of unknown objects for dual-manipulator humanoid robots

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Introduction

- Why is it important
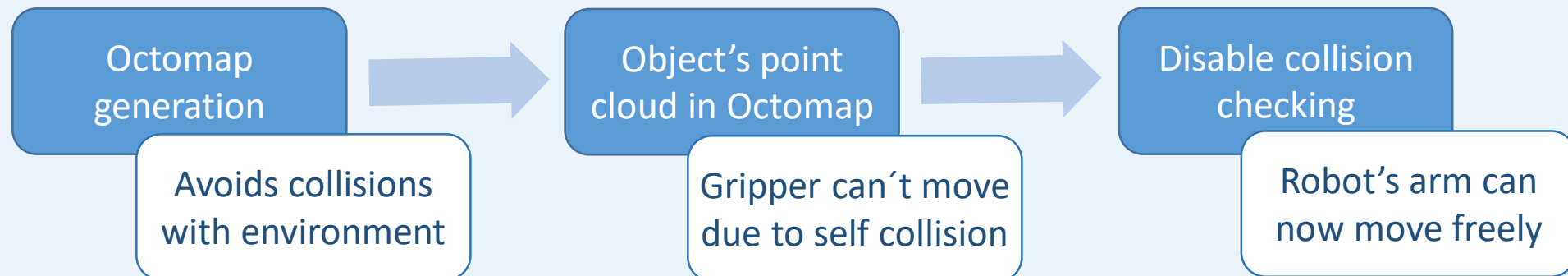- 3 groups for object placements (pg2)
- General overview

Tracking gripper & Disabling collision checks

1. Tracking equations:

$$pan = atan2\,(y, x)$$

$$tilt = atan2\,(z, \sqrt{x^2 + y^2})$$

2. Collision avoidance:

Octomap generation	→	Object's point cloud in Octomap	→	Disable collision checking
Avoids collisions with environment		Gripper can´t move due to self collision		Robot's arm can now move freely

Selecting arm poses for object's visualization

- Two revolute joints rotated to keep the center of mass of the object stable-> no pre-alignment needed
- in the future make them dependant on what has not been seen yet

Insert fig 1 and 2

Model creation: Filtering

- Depth images to 3D pointclouds
- Points further than the length of the extended arm or closer than the minimum reach are removed
- Filter points that represents the robots surface out -> 2 pointclouds
- Keep the robot+object pointcloud to do the NICP and apply the results to only the objects pcl

- Add image page 6

Model creation: Transforming points to gripper frame

- PCL will become invariant to the grippers movement
- No need for pre-alignment (i.e. FPFH descriptors)
- Still need for NICP algorithm or else:

- Image page 7

Model creation: NICP algorithm

- Based on point coordinates, surface normals and curvature. Works best with small differences between pcls

- Applied to robot+objetc pcl. The transform solution is used on the object-only pcl

Insert Fig 5

- Smoothing process Moving Least Squares (MLS) to reduce noise

Insert Fig 6

Model creation: Changing hands (180 deg)

- Main reason: Occlusions
- Grasping poses can be hard-coded or found based on the geometry of partial model
- Repeat whole procedure, both partial models have the same reference

Insert Fig 7

Model creation: Merging both partial models

- Same frame
- Offset due to changing hands -> Prealignment using FPFH descriptors
- NICP algortihm to fully align.
- Moving Least Squares algorithm
- Building mesh of models

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Experimental results

- 4 objects were tested (2 boxes and 2 bottles)
- Size differences always below 6 mm (9%)
- Overall shape is correct except when the MLS threshold is set too high -> Flatens curvatures
- Errors in pre-alignment or NICP processes if there are major discrepancies between pcls. -> More viewpoints with less difference between them
  - Also More details by Fine-tunning the filtering of points of robots surface -> less occlusions

Conclusions + future work

- Correct 3D models are generated with the proposed approach
- Future Grasps based on the objects and grippers geometry
    Insert Fig 10

- Future work:
    - Loop closure
    - Next best view concept
    - Use work in real life scenarios