InPicker: Random Bin Picking
Last step for a complete Factory Automation Process
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Problem definition

- Random BinPicking:
  - In the Vision Guided Robotics context, Random Bin Picking is the ability for a robot to pick objects, randomly arranged inside a bin, to be placed into the next tooling or production process.
Problem definition

- Objects can be together, overlapped, tangled, etc.
- Varying depth of the objects:
  - Problems in focus, scale, shape variations, specular highlights, ...
  - Far from ideal conditions for Computer Vision.
- Objective: Measure the x, y, z, roll, pitch, yaw of the object (6D).
- Usually, a solution can be found if restrictions are applied depending on the kind and shape of the object and the environment.
Problem definition

- The container, the robotic arm and the whole environment needs to be modeled to avoid collisions.
- It is not only a machine vision problem, but in fact, one of both robotics + machine vision.
InPicker Overview

- INFAIMON has developed InPicker, a software able to solve the Bin Picking problem.
  
  - Contactless examination,
  - Dynamic exploration,
  - Environment modelling,
  - Collision avoidance,
InPicker Overview

- INFAIMON has developed InPicker, a software able to solve the Bin Picking problem.
  - Easy setup.
  - No Vision expertise required.
  - No Robotics expertise required.
  - Independent of the robot model.
  - All bin and object sizes.
InPicker Overview

Coordinate Systems

Principal coordinate systems in InPicker:

- **World (W)**: Is the reference coordinate system for the 3D locations of the objects to grasp. Usually located at:
  - Robot’s base.
  - A custom robot’s *WorkObject*.
- **Robot Wrist (Tool₀)**: End of the robot in which tool is fixed.
- **Hand, Tool or grasp (H or TCP)**: Point in which the robot acts. Center of suction cup or magnet, middle point between gripper fingers, etc.
- **Object or part (O)**. Usually in the object’s center.
- **Grasping point (Gᵢ)**. Coordinate system in the object where the tool acts to grasp the object. In general min. 2 defined.
- **Camera or Eye (C)**. Imaginary point coincident with the camera’s optical center. In stereo sensors, the coordinate system is located in the left camera’s optical center.
- **Bin or Container (B)**. It’s where the objects are: box, belt, blister, table, pallet, ...
InPicker Overview
Coordinate Systems
InPicker Workflow

ACQUISITION  FILTERING  6D OBJECT DETECTION
InPicker Workflow

1. Grasping Position
2. Avoid Collisions
3. Send Coordinates
InPicker Workflow
Acquisition

3D Technologies

Stereo Vision  Projected Texture Stereo  Fringe Projection

Laser Triangulation  RGB-D
InPicker Workflow
Filtering

- Elimination of irrelevant points and noise from the cloud.
- Objective is to only keep container and its contents.
- Exception: avoiding collisions with the camera perceived environment.
InPicker Workflow

Object Detection

- We select the best Object Detection algorithm for every object from our algorithm portfolio.

- Customization of the Object Detection algorithm.
InPicker Workflow
Grasping points
InPicker Workflow
Collision Avoidance

- **Collision types that we can control:**
  - Tool – Bin
  - Tool – Other Objects
  - Tool – Scene

- **Collisions that we don’t control:**
  - All related to the robot except for last link
  - Scene elements not perceived by the camera.
InPicker Workflow
Send Coordinates

\[ wT_G^{21} = wT_C \cdot cT_{O2} \cdot oT_G^{21} \]
Applications

- **InPicker principal competitive advantages:**
  - Proprietary software. Capacity to modification and customization.
    - SW costs adaptable to Project.
  - Independency from HW: 3D cameras and robots.
    - Cost adaptability (bin picking, rack picking, belt picking).
    - Camera prices depending on customer needs.
    - Possibility of Static or In-Hand camera setup.
  - Friendly Interface and easy programming.
  - Success cases in all countries. With many videos.
  - Different matching possibilities: CAD-based and model-less.
  - Possibility of using Deep Learning algorithms if needed.
Applications

Random Bin Picking

Arranged Bin Picking

Unit Picking

Belt Picking

Rack Picking
Applications
Applications

Final customers

System Integrators
Thank you

www.inpicker.com