Automatic Robotic Rivet Screwing Based on Image Processing and Laser Scanning

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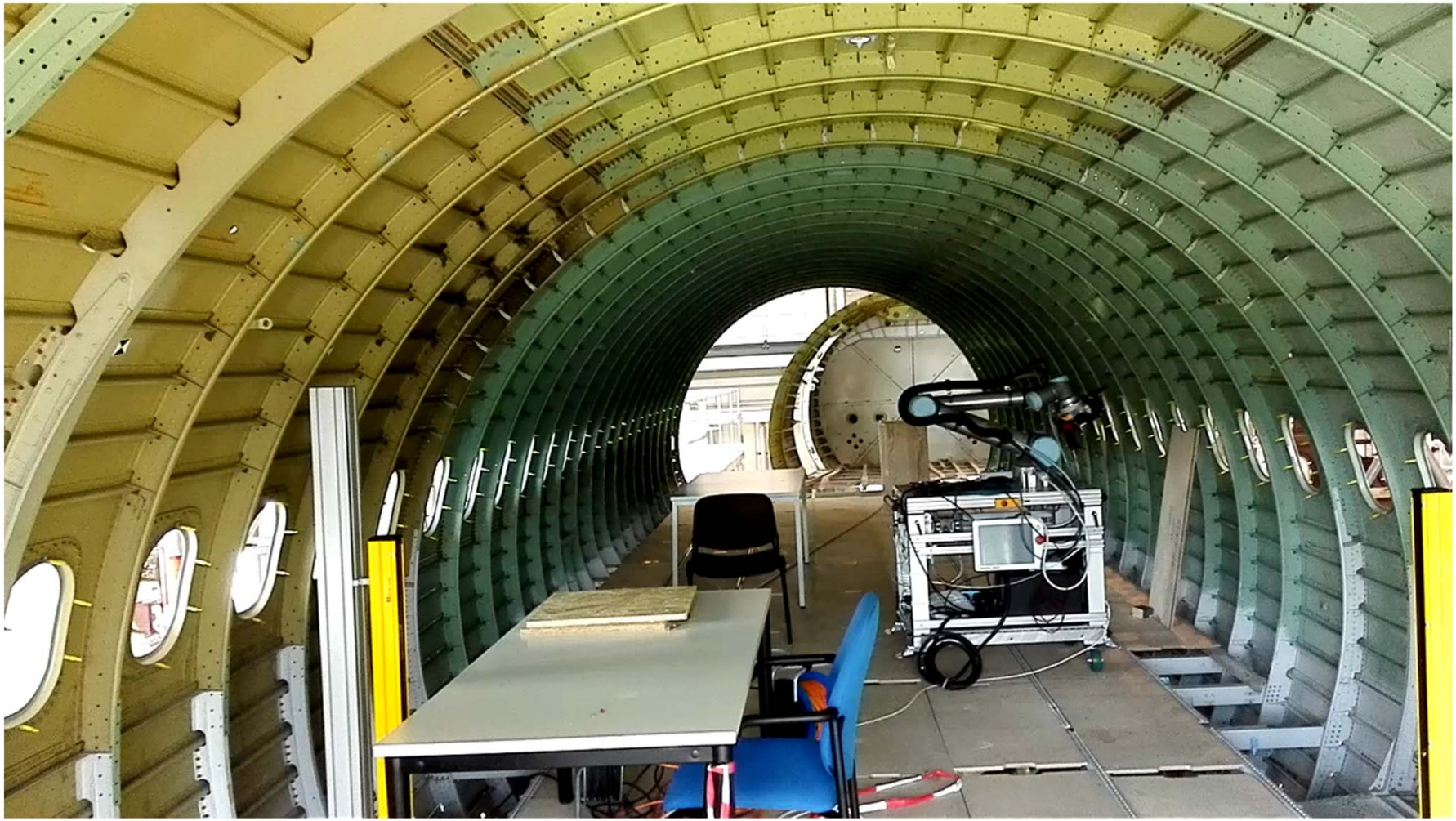
Introduction



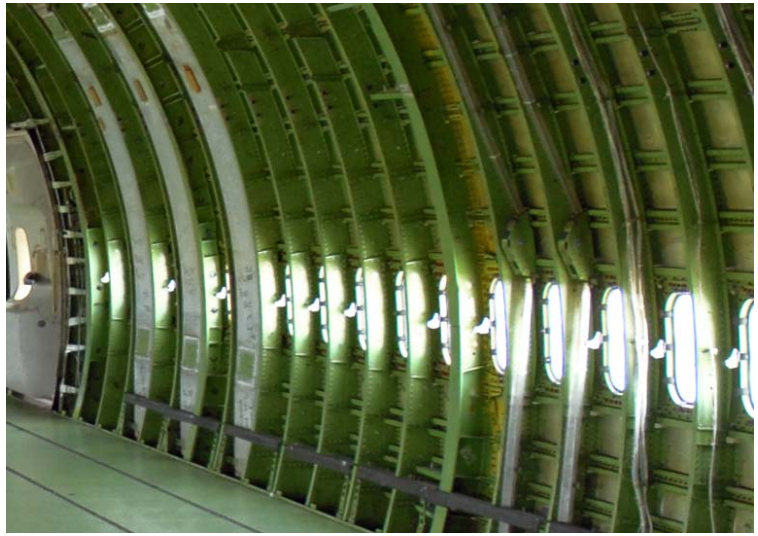
Introduction

- Precise positioning is important for rivet screwing in airplane assembling
  - The diameter of the nut is 6.1 mm
  - The diameter of the screw is 3.2 mm
  - The error tolerance for rivet nut gun
    - Is around 1 mm

Introduction

- Precise detail position information of the whole sense is not easy to get
  - e.g. commonly used 3D Lider (Velodyne HDL-64E: ±2 cm)
  - Finding small structures in a large 3D model is time-consuming
- For movable robot, precise position is diffcult
  - 2D Lider (Pepperl+Fuchs R2000: 12mm)

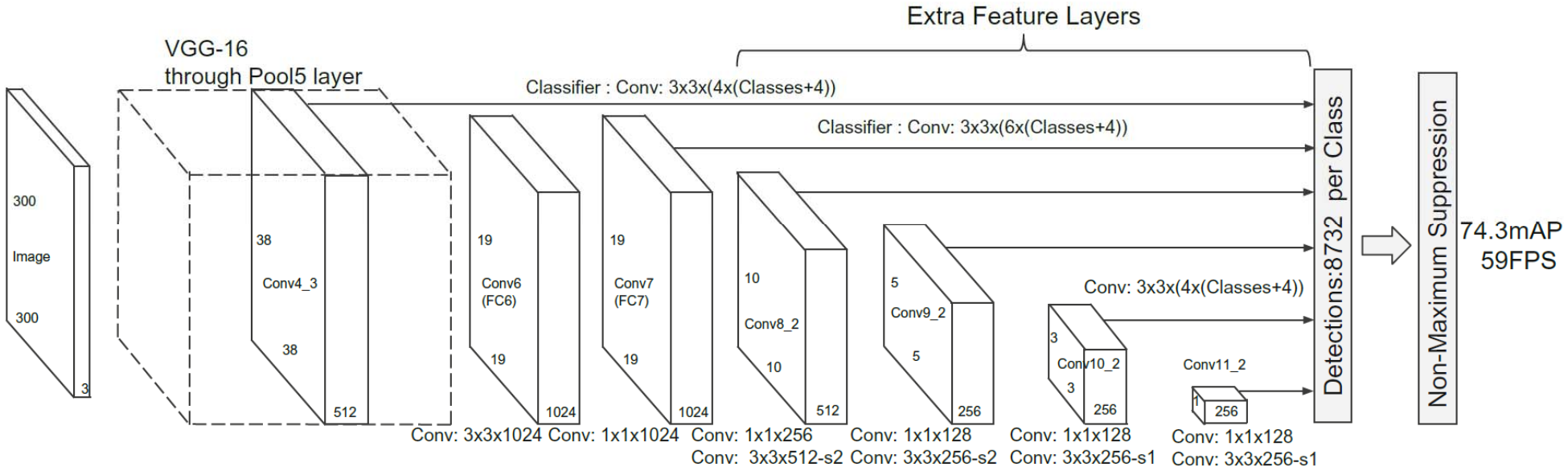
  - We need to move the robot inside the airplane



Proposed Method

- Two-stage positioning
- Rough location
  - Base on the image processing and related point cloud
  - Object detection is almost real time using neural network
- Local precise positioning
  - Using high precision laser scanner

Single Shot MultiBox Detector (SSD)



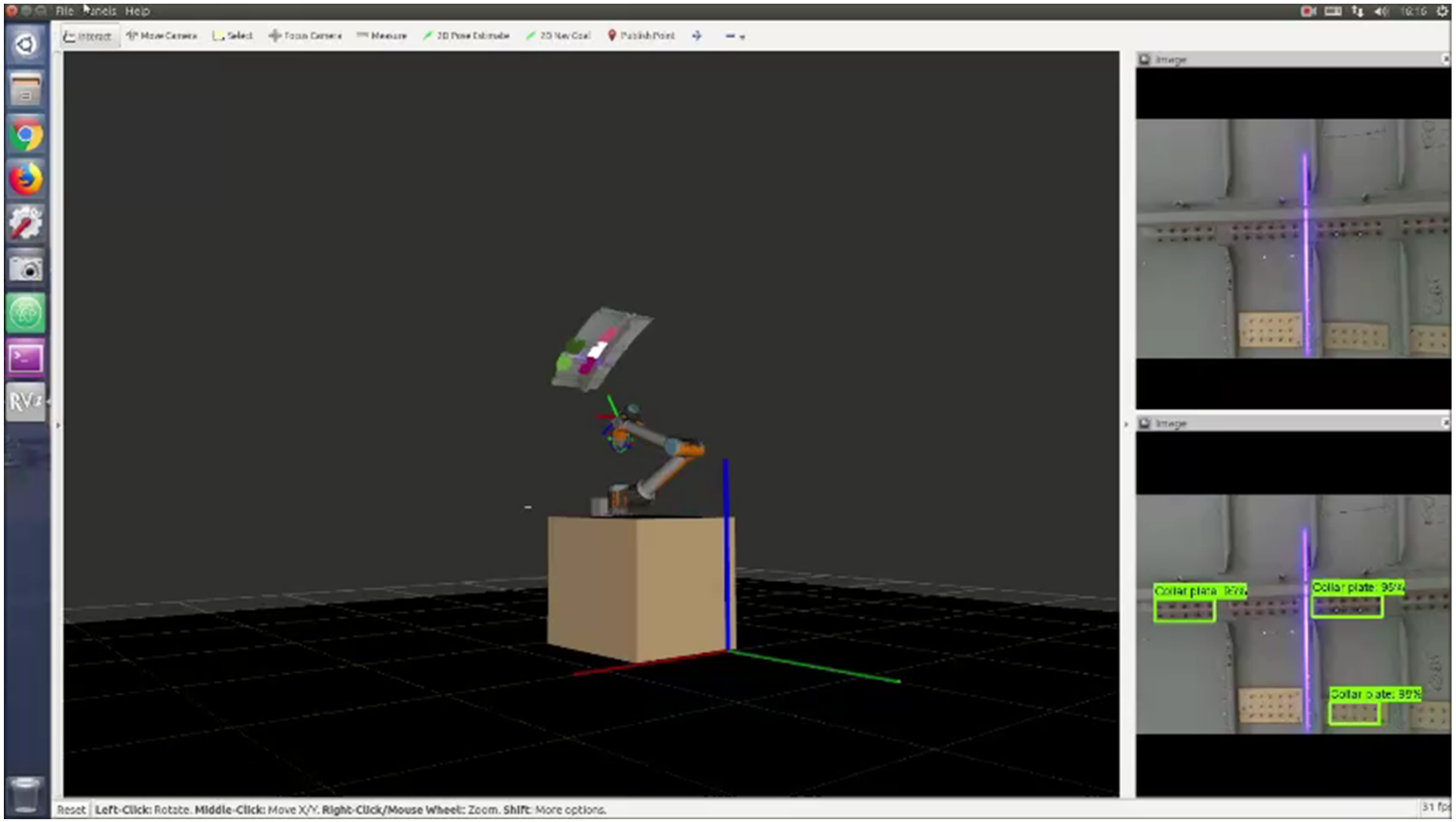
fixed-size collection of bounding boxes and scores
non-maximum suppression (nms)

Model name	Speed (ms)
ssd_mobilenet_v1_coco	30
ssd_mobilenet_v1_0.75_depth_coco ☆	26
ssd_mobilenet_v1_quantized_coco ☆	29

faster_rcnn_resnet101_lowproposals_coco	82
faster_rcnn_inception_resnet_v2_atrous_coco	620
faster_rcnn_inception_resnet_v2_atrous_lowproposals_coco	241
faster_rcnn_nas	1833

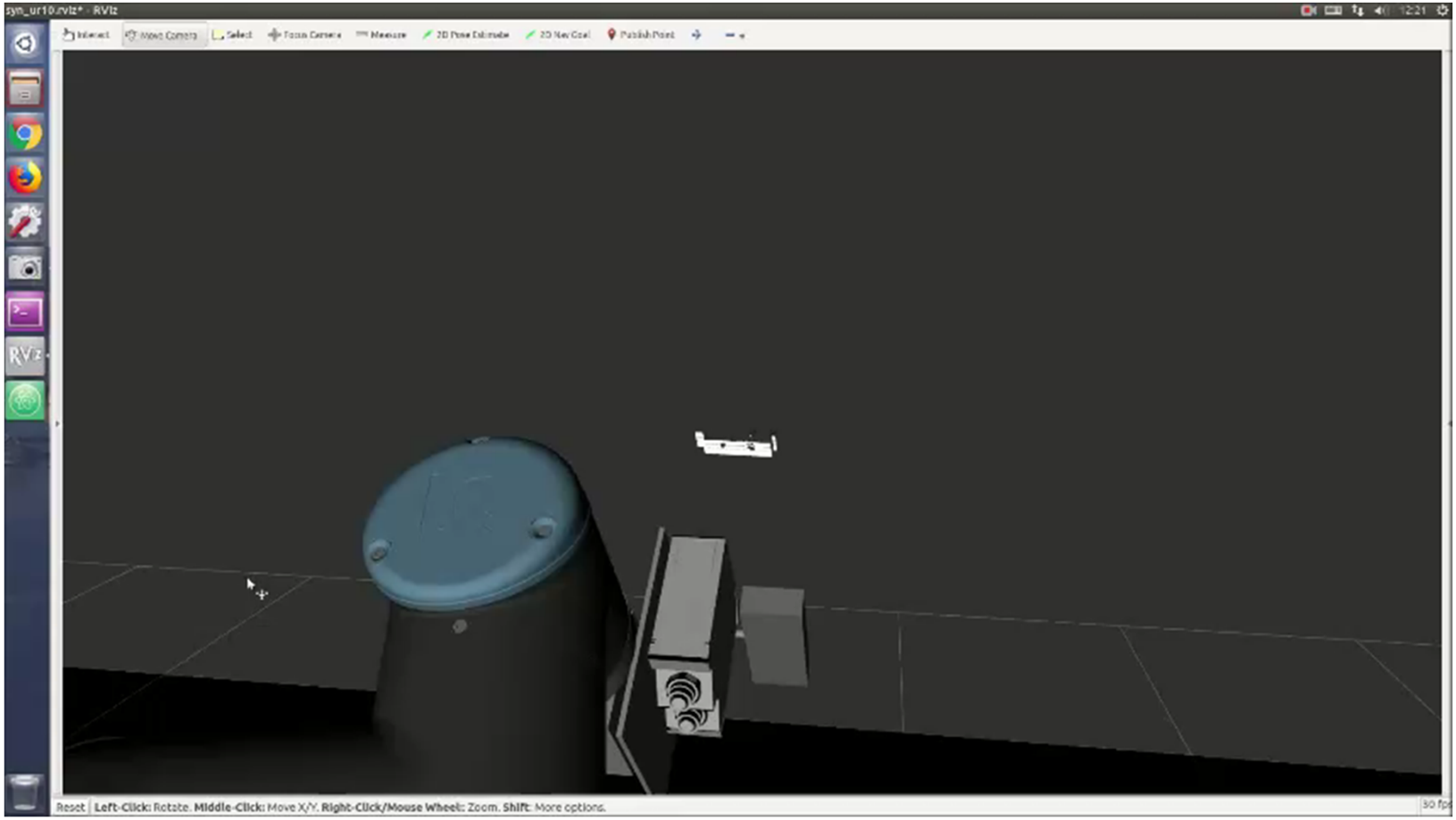
Rough Location

- Using SSD with Mobilenet V2, speed: 31 ms
- Cutting point cloud within the bounding box to generate scan plans



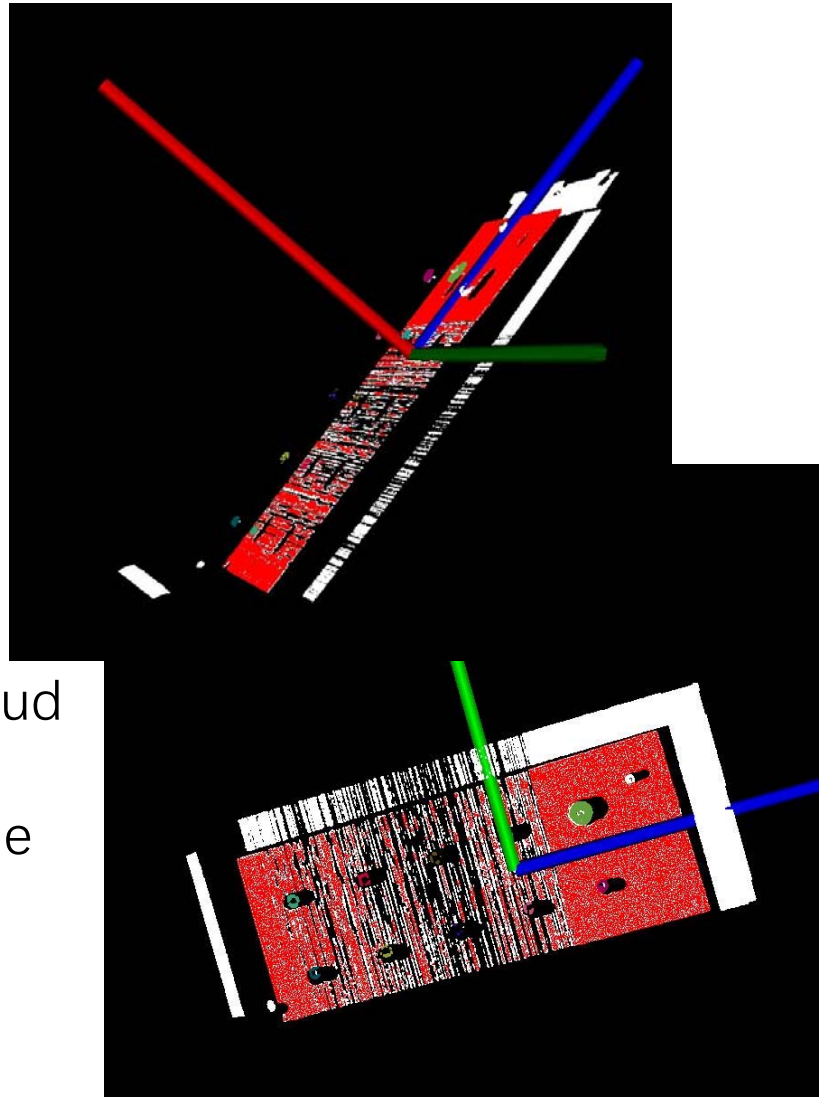
Local Precise Positioning

- Scanning the identified areas

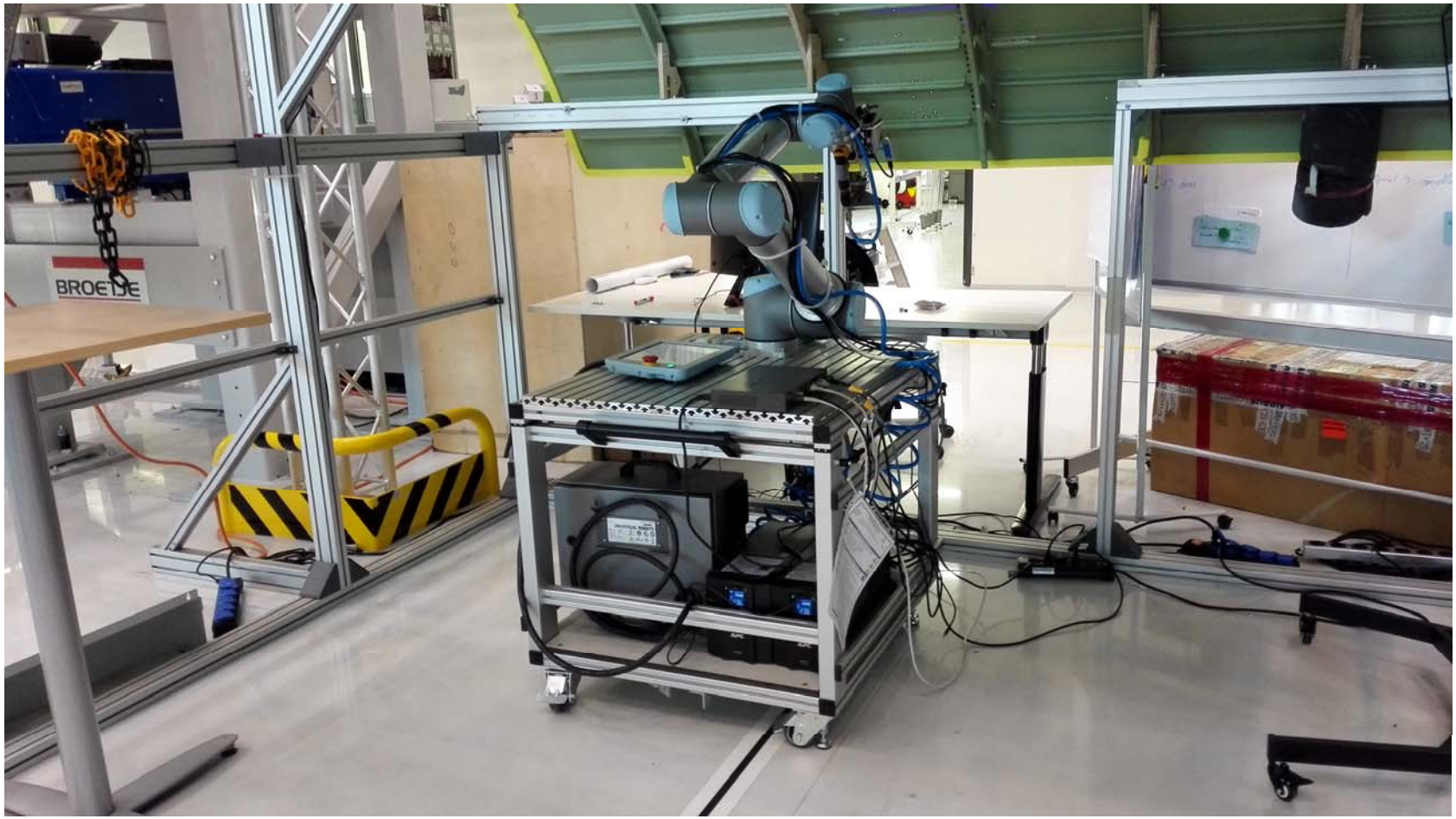


Local Precise Positioning

- Process the scanning point cloud
- Find the supporting surface
  - RANdom SAmple Consensus (RANSAC)
  - Fitting a plane model
  - Using Principal components analysis
    - To find the initial model parameters
- Find the rivets
  - Transform and rotation the whole point cloud
    - Make the support surface on the y-z axis plane
  - Project the point cloud on the y-z axis plane
  - Fitting Circles Using Hough transform



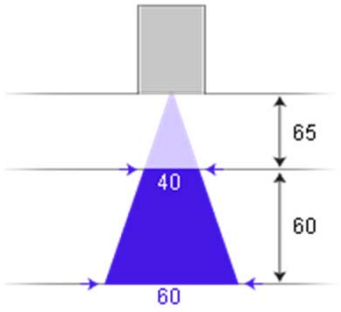
Experiment Setup

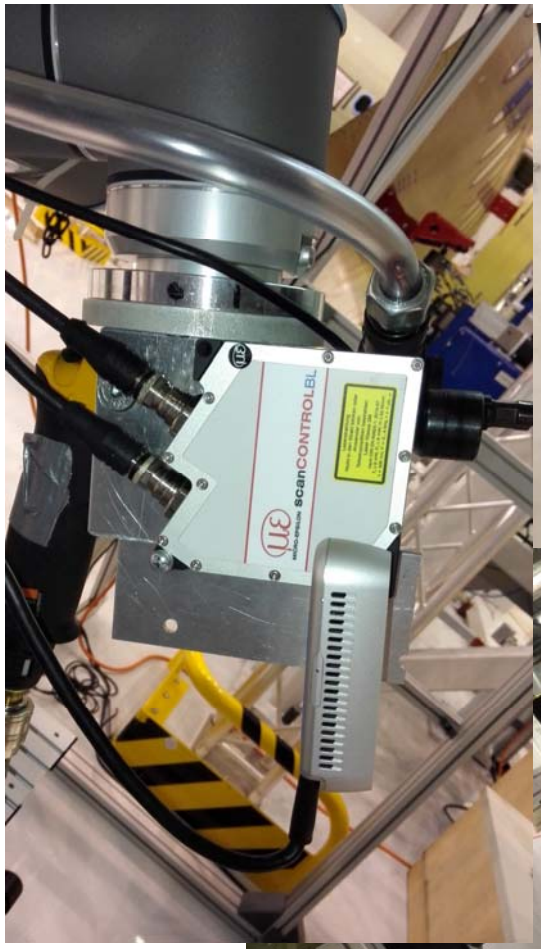


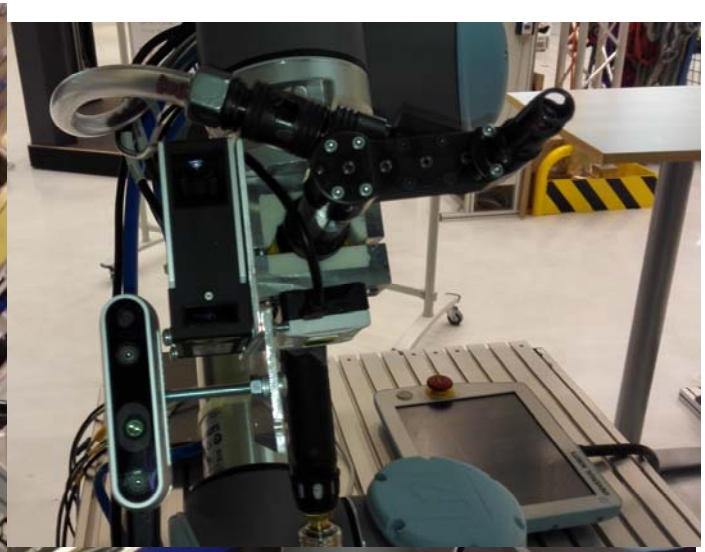
Experiment Setup

Experiment Setup

- UR10 on a movable table
- Intel Realsense d435
  - Image + PointCloud
  - Maximum Range: Approx. 10m
- scanCONTROL 2900-50
  - z-axis Resolution: 4µm







Preliminary Result