X-act project

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Dual arm robots for skilled manufacturing operations

Dual arm robots for disassembly

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Content

- Why dissasembly
- Scenario description
- System design and technologies involved

ALFA Hogar

- Small company in a big group
- Design and commercialization of electrical appliances

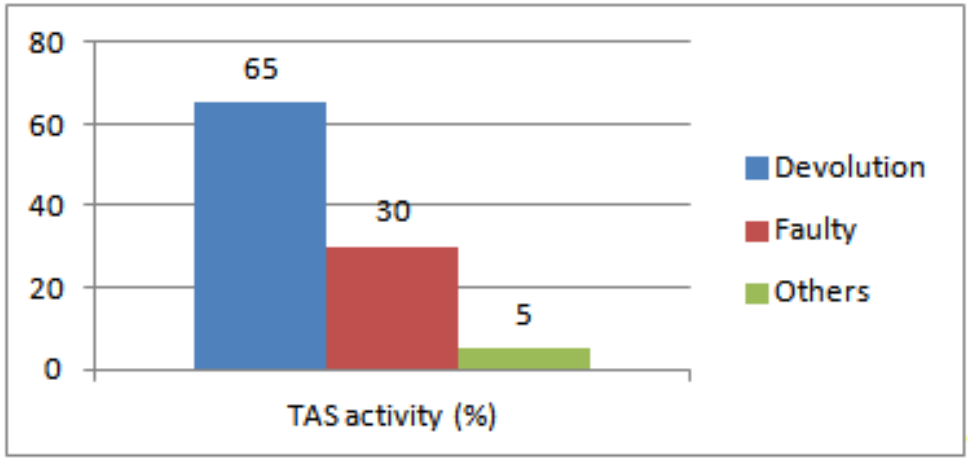




- All production is done in ASIA
- The reworking of electrical appliances is not the core business of ALFA
- Technical Assistance Service (TAS) has a big impact on the objective of achieving **customer loyalty.**

Technical Assistance Service activities

- Products that are sent back by the commercial network. They are not faulty elements, but products that need to be verified (or not) and re-packaged in new boxes
- Products with a defect.
- Others (including order cancelation)



Selected product: Sewing machine

- Representative product for the company:
  - It is the most important product
  - It represents over 75% of the total working time of the Technical Assistance Service (TAS)
- The project developments can also be applied to other products and operations (e. g. Assembly)

TAS= Unpackaging + Disassembly + repair + assembly + packaging

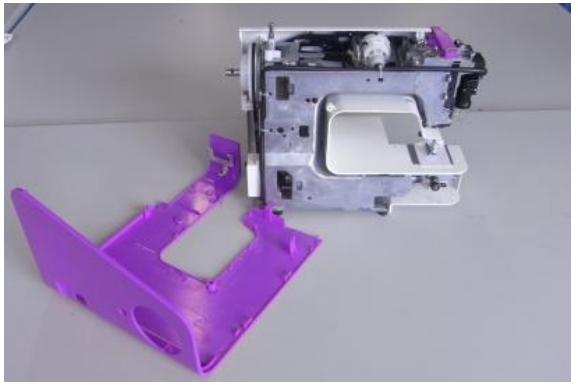
We will focus on **unpackaging and disassembly**

Type of activity	Actions	Activity (%)	Action (%)	Process time (min)	TOTAL time (min)	A	B	C	∑ABC
Commercial reimbursment	Only re-packaging	65%	70%	3	7	57%			57%
	General inspection		30%	15	19	21%			21%
Faulty material	Only re-packaging	30%	8%	3	7	57%			57%
	General inspection		12%	15	28	14%	32%		46%
	Motor replacement		16%	6	19	21%	47%		68%
	Shuttle adjustment		10%	10	30	13%		53%	67%
	ZIG-ZAG arc adjustment		9%	10	23	17%	39%		57%
	Cover change		9%	4	24	17%		67%	83%
	Top tensioner adjustment		10%	10	30	13%		53%	67%
	Machine release		13%	4	24	17%		67%	83%
	Tractor tooth adjustment		7%	4	24	17%		67%	83%
	Transport cam adjustment		6%	6	26	15%		62%	77%
Cancelled orders and others	Only re-packaging	5%	60%	3	7	57%			57%
	General inspection		40%	15	19	21%			21%

Process time = time needed for the repair operation (no unpacking/packing).
Packing/unpacking time is estimated in 4 minutes
Total time = process time + packing/unpacking time
A: relative weight of (un)packing / B: relative weight of covers removal
C: relative weight of complete (dis)assembly / ∑ABC: relative weight of non added-value operations

In most cases the amount of time spent in non added-value operations is **over 65%**. Any improvement in terms of reduction of time has a high impact in ALFA's efficiency.

The target: To disassemble the sewing machine



Operation 1. Unpacking the sewing machine





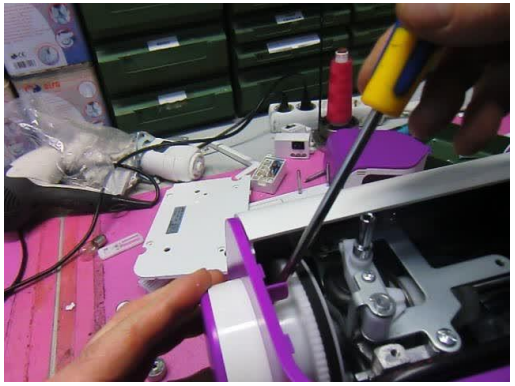

Operation 1. Unpacking the sewing machine

Operation 2. Removal of the extension plate

Operation 3. Removal of top cover

Operation 4. Removal of plastic caps and handwheel

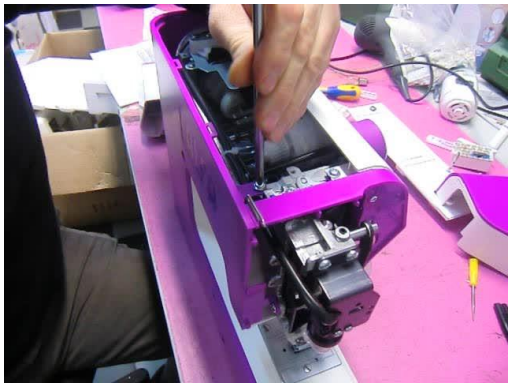




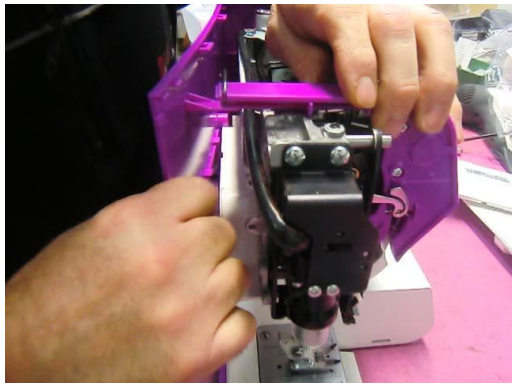
Operation 5. Removal of face cover

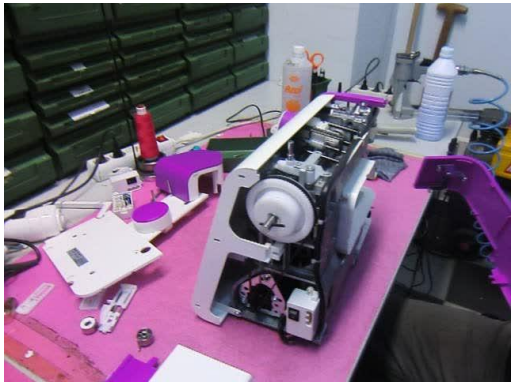

Operation 6. Removal of bottom cover

Operation 7. Removal of main screws

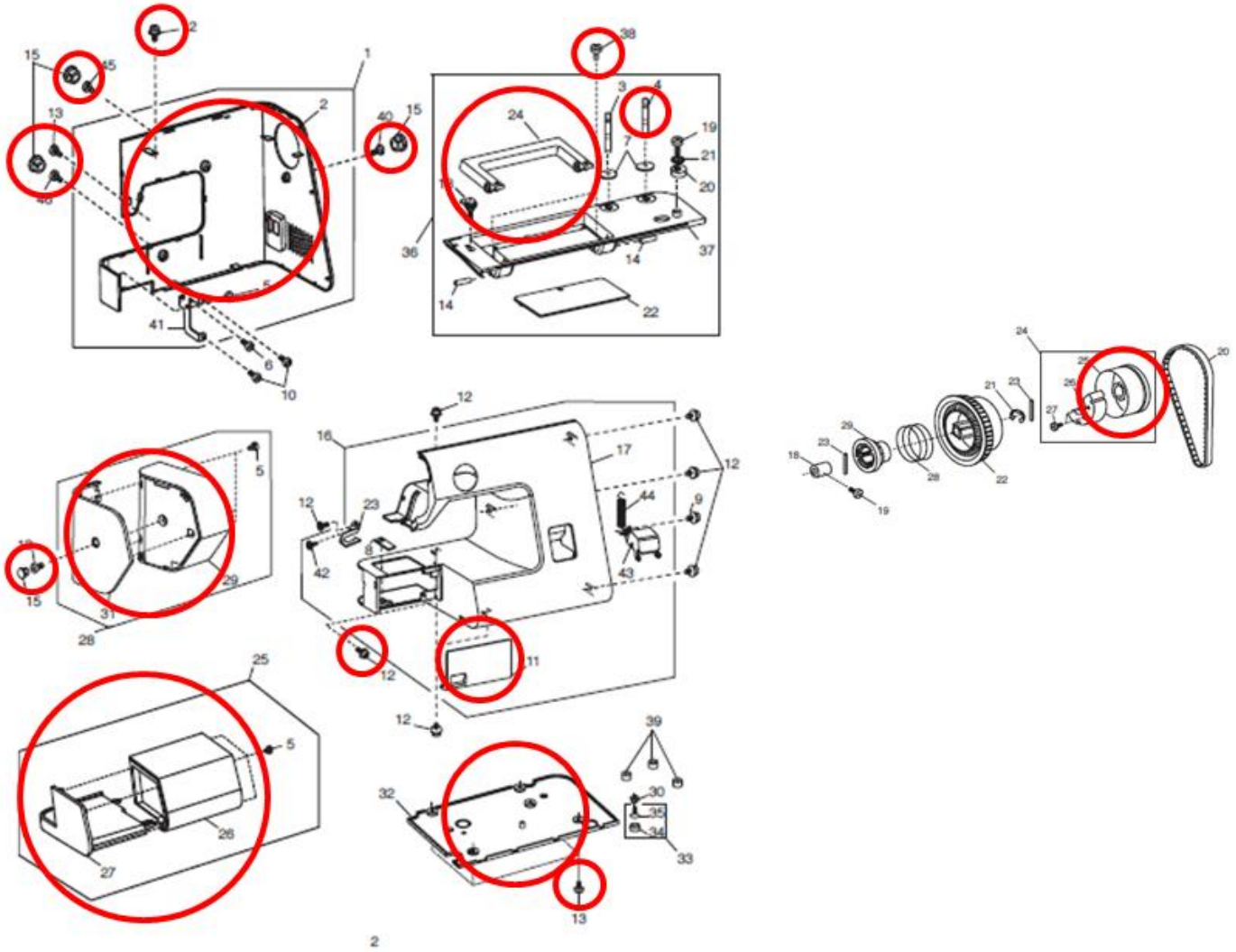


Operation 8. Removal of plastic covers

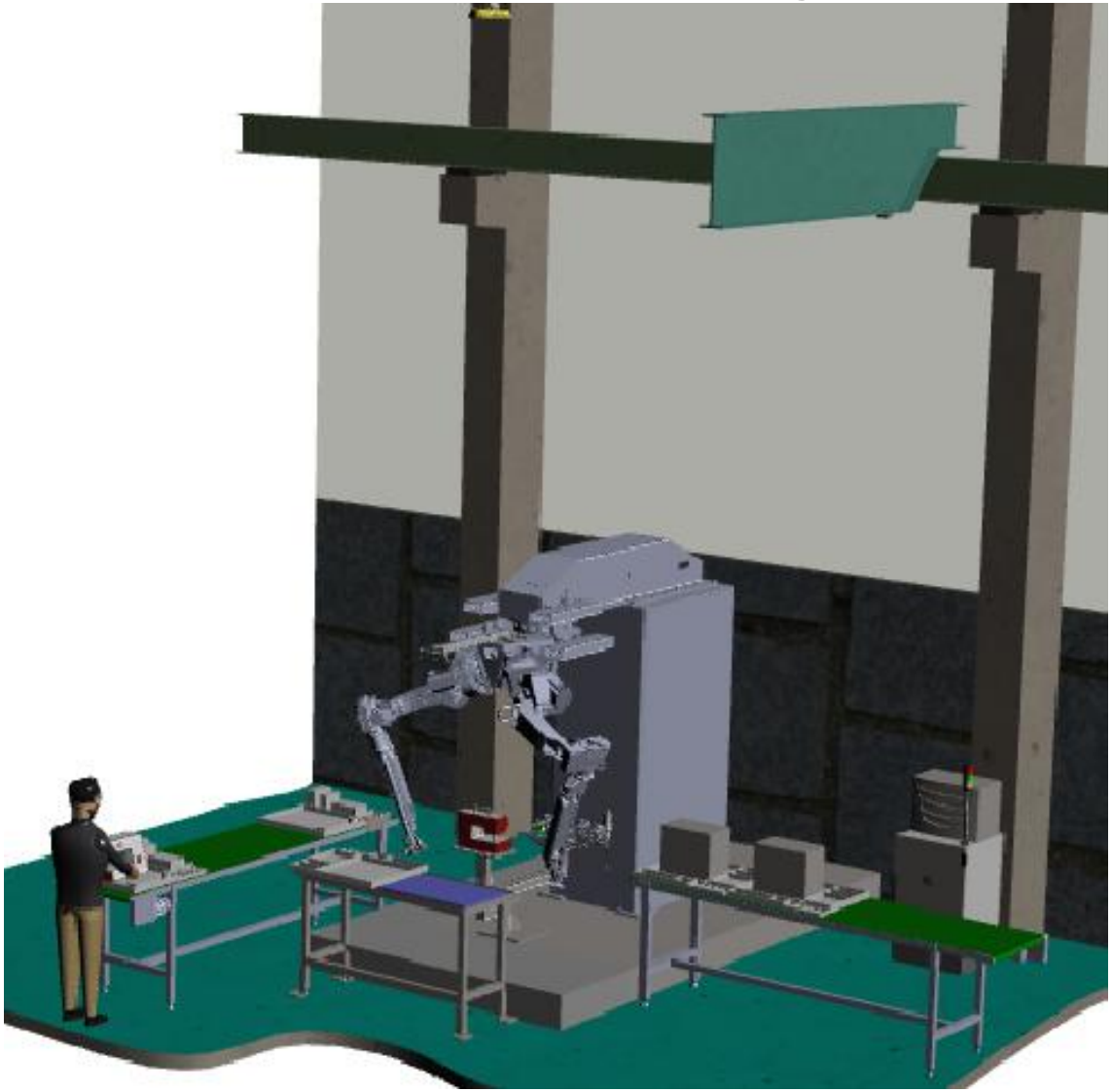


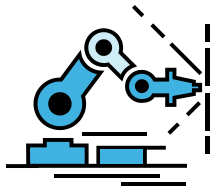


ALFA scenario: Sewing machine components



Cell design





Layout

Cell elements

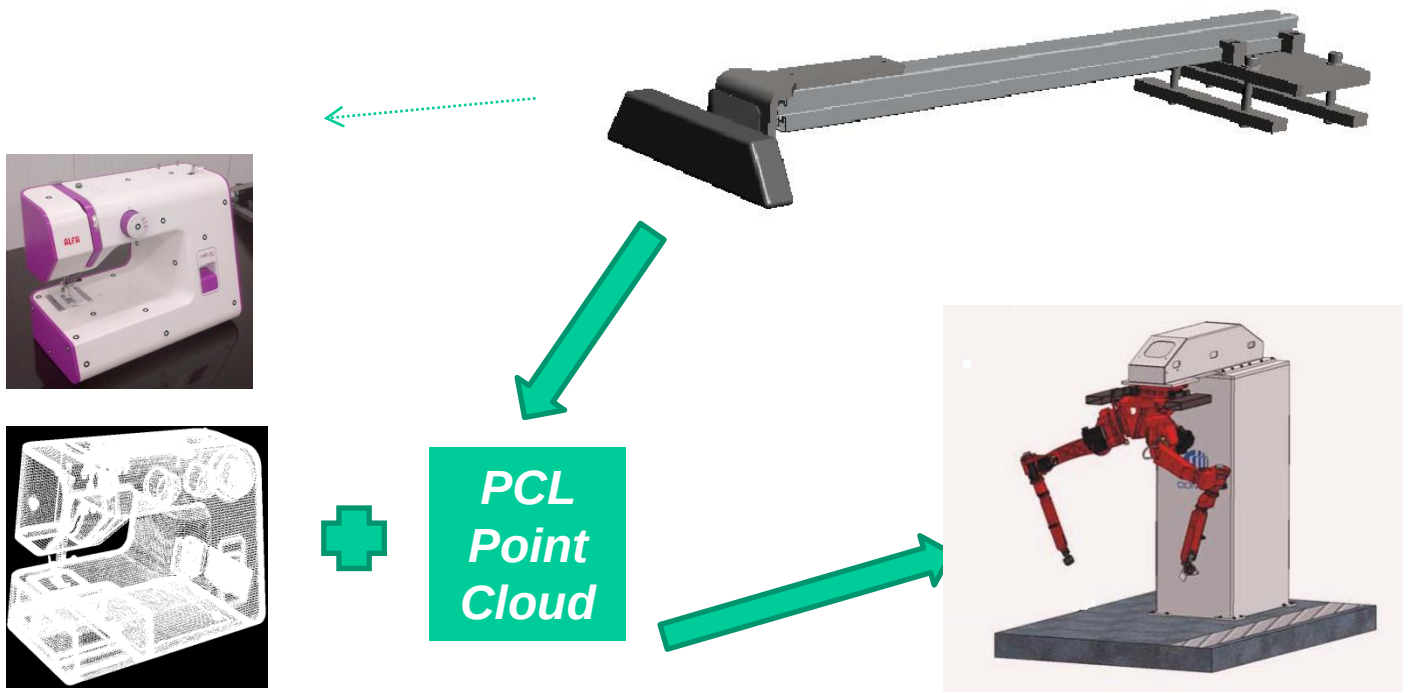
- RML robot
- Tooling system
  - Tools
    - Vacuum cups
    - Screwdriver
  - Tool exchange station
- Object pose identification
  - Eye-in-hand Camera
  - Zenith camera
- Other elements
  - F/T sensor
  - Workbench and Conveyors
  - Tray
- Safety elements
  - SafetyEye
  - Human monitoring cameras
  - Laser rangefinder
  - Others

Object detection

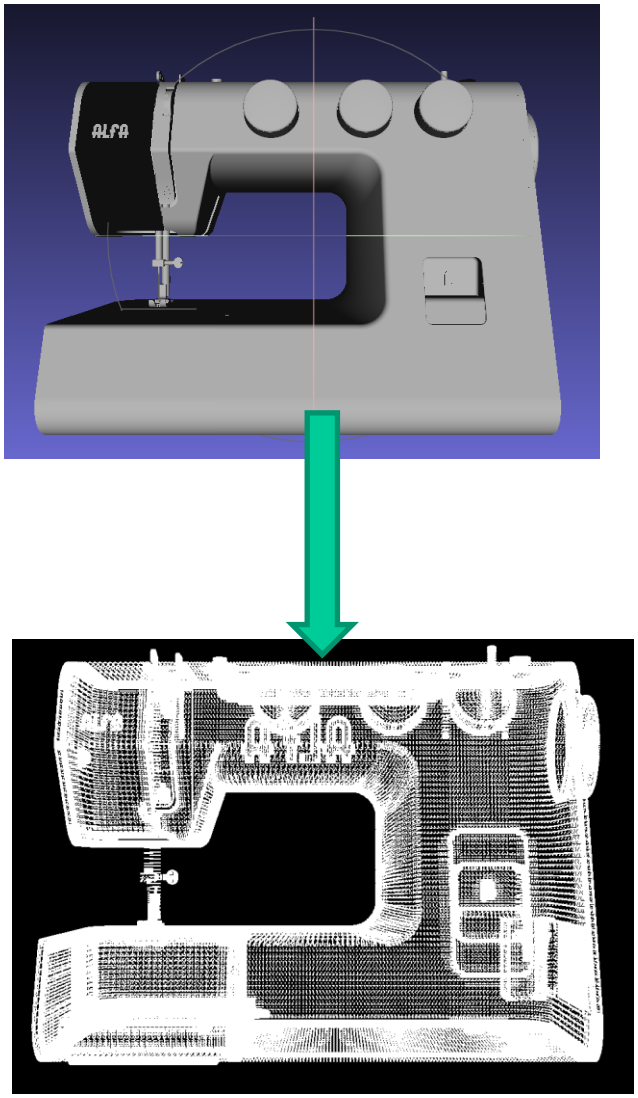
- Object detection using machine vision
  - Why
    - Location of BOX on the conveyor
    - Location of sewing machine on the workbench: no fixturing elements
  - How
    - 3D approach
    - Zenith camera mounted on the torso (arm 3)
    - Automatic identification based on point clouds and 3D CAD model
- Fine positioning of Tools
  - Why
    - Need of ‘high’ precision on some operations
  - How
    - 2D approach
    - Eye-in-hand camera

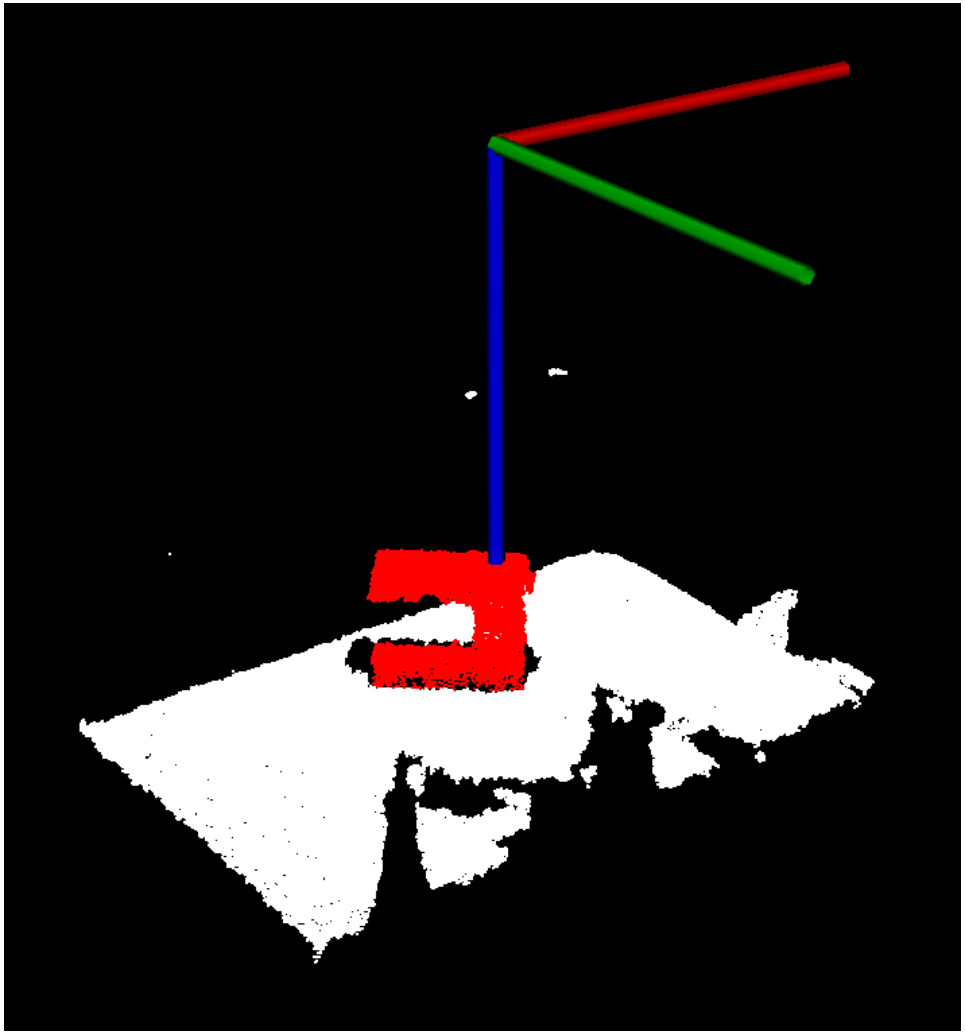
6DOF object recognition, 3D Point Clouds

- Design of an integrated system for 6DOF pose estimation using:
  - Kinect as 3D sensor to obtain real time point clouds
  - CAD of the sewing machine as a matching model



6DOF object recognition, 3D Point Clouds

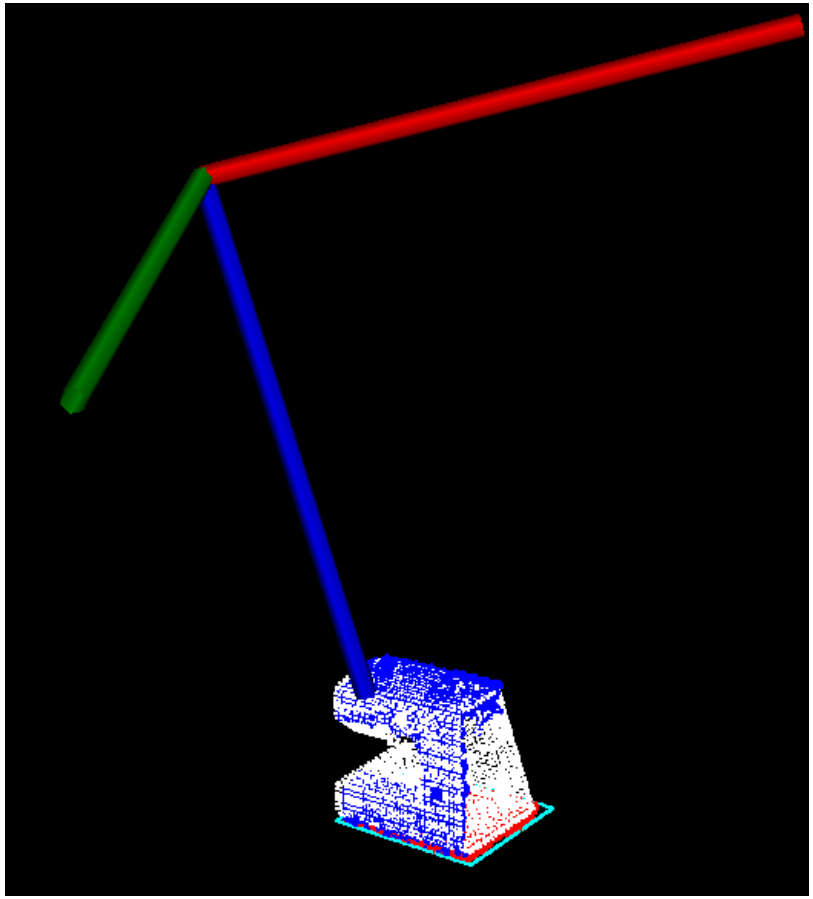


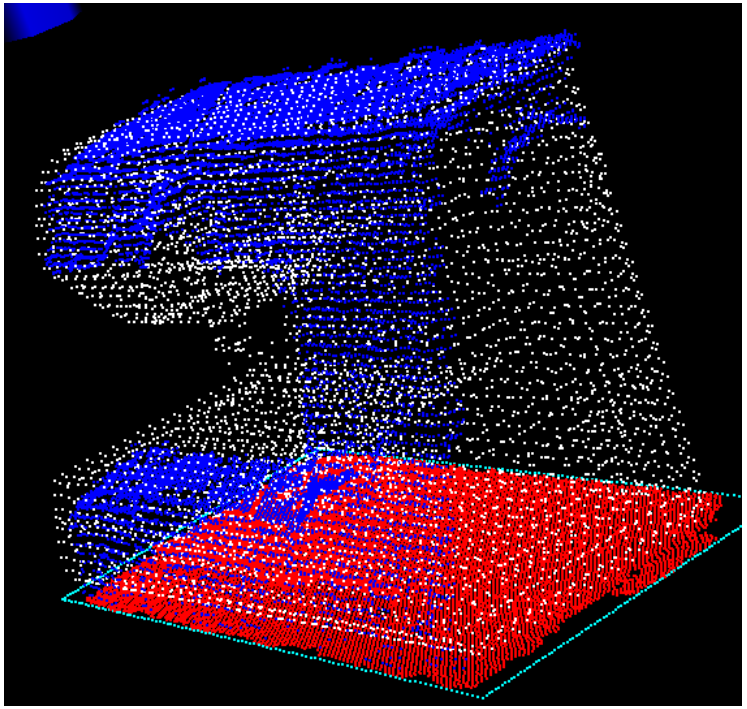


Overall scene (white points) and filtered object (red)

6DOF object recognition, 3D Point Clouds (Work Done)

Matching the model (white) with the scene object (blue)





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POSITION 1

Inicio de calculo de convergencia por ICP

Iteraciones: 250 Epsilon: 0.001
Convergencia: 1 Score: 0.00385648 (suma de dist Eucl. de Error)

   0.999995 -0.00041775  0.00370651 -0.00322917
0.000312704    0.999595   0.0285204   -0.028568
-0.00371648  -0.0285193    0.999588  -0.0119268
          0           0           0           1

Tiempo de procesamiento: 1 s
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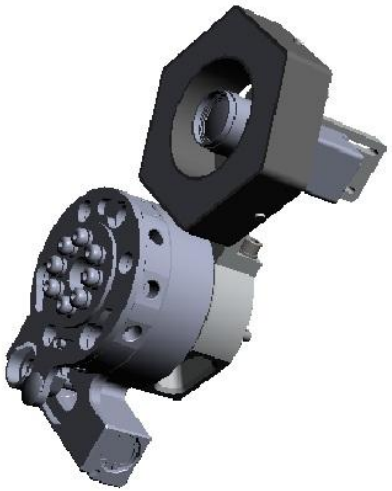
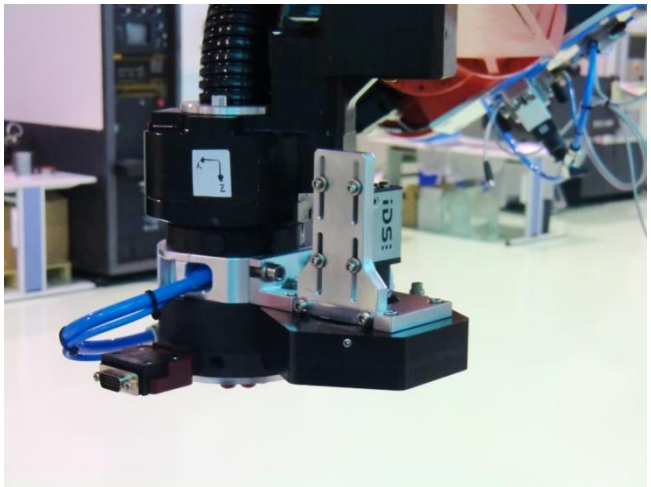
Visual Servoing

- Proposed approach
  - Dynamic look-and-move
  - Eye-in-hand configuration
  - 6DoF pose estimation using 2D camera



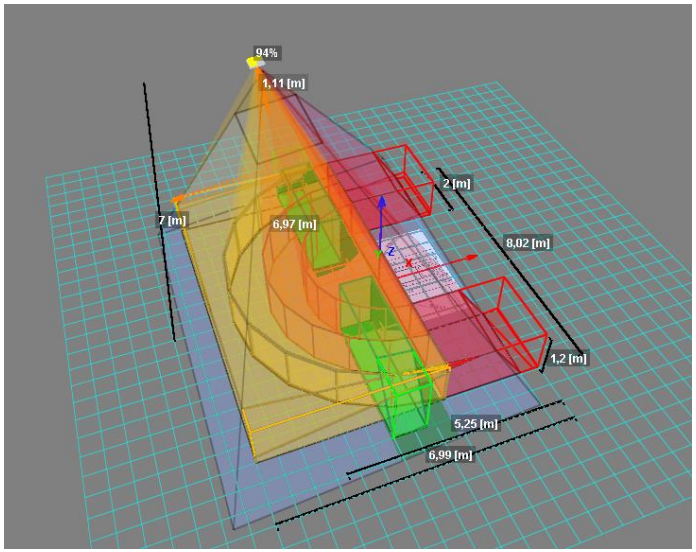


Motion planning

- Types of movements
  - Coordinated-simultaneous movement of both arms (box and machine manipulation)
  - Synchronized movement of both arms (the rest)
- Path generation and control
  - Off-line programming
  - Real time trajectory adjustment
    - Visual servoing
    - Force control : Screwing

Safety mechanisms

- Safety Eye
- Distance and velocity monitoring system
  - 2 Laser rangefinders
  - Vision System
- Signalling mechanisms
- Other measures
  - Operation in the sharing space
    - Arms completely extended
  - Interference volume
    - Configurable robot working volume
    - Work inside / outside it
  - Interlock key



Current status

SIMULATION

CURRENT STATUS