Development of intelligent systems (RInS)

Task 3: RoboSheriff

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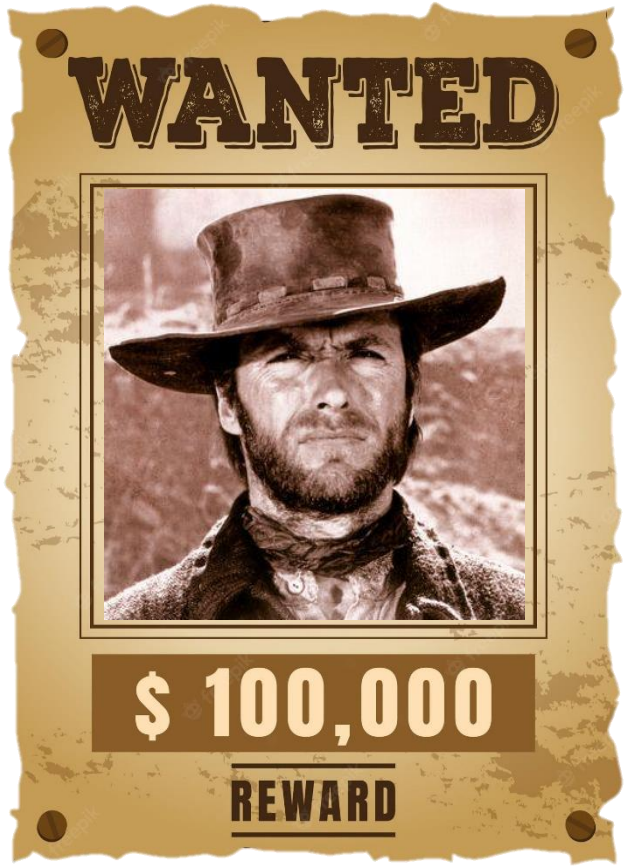
2023 Final task

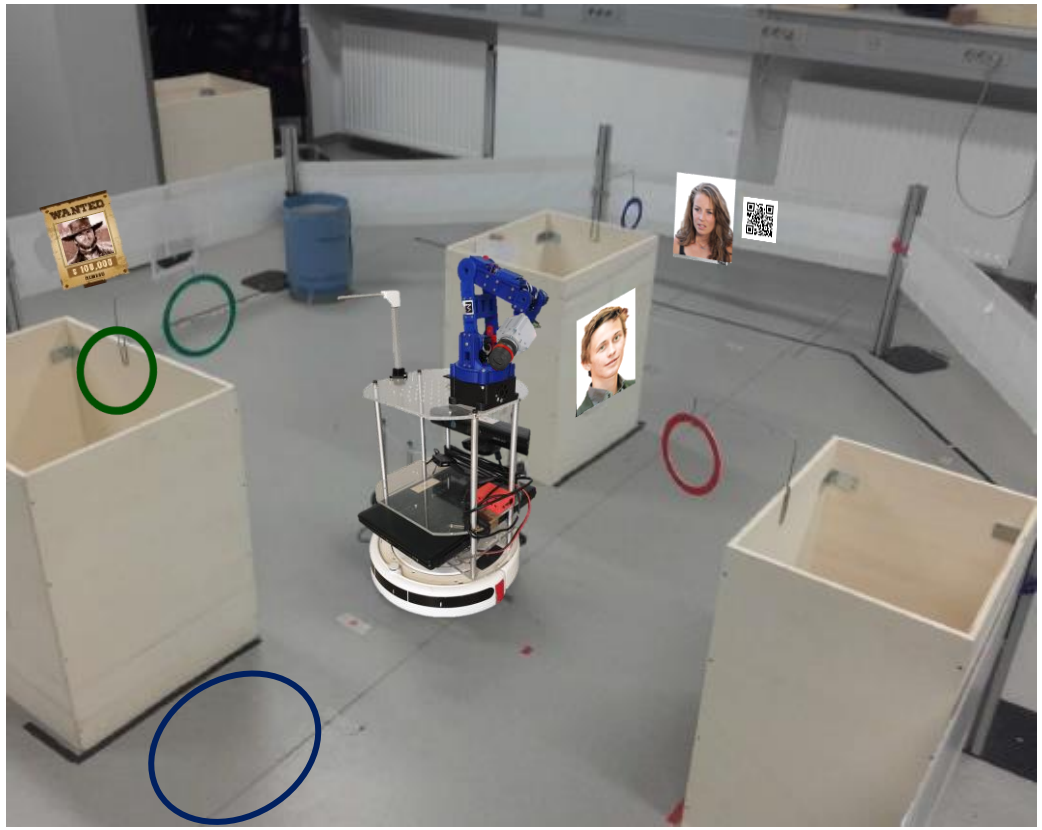
RoboSheriff

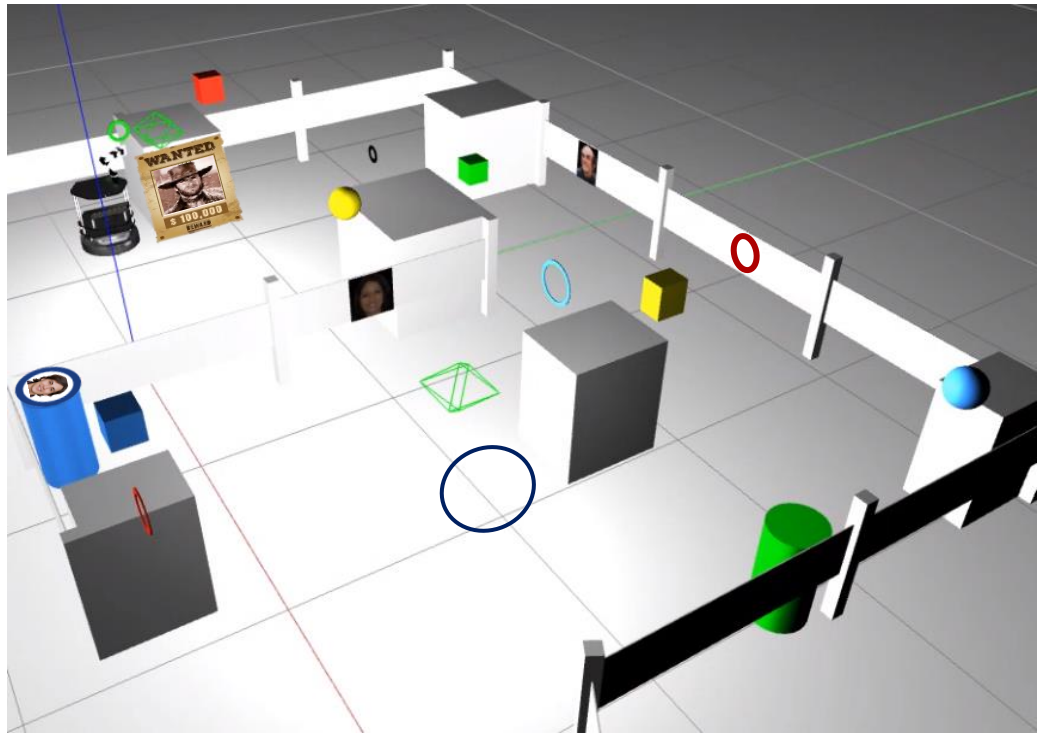


2023 Final task

- Setup:
  - „Small wild west city“ scene (fenced area).
  - Several persons (faces) in the scene.
  - Several „Wanted“ posters in the scene.
  - Four „buildings“ (cylinders) of different colours.
  - Four parking slots marked with rings of different sizes and colours.
- Goal:
  - Imprison the robber.
- Task:
  - Find all persons in the city.
  - Find the posters and decide which robber to find and catch.
  - Talk to persons to find out where the robber is potentially hidding.
  - Look on the top of buildings (cylinders) if there are robbers hidden.
  - When a robber is found, „take“ him to the prison.
  - Find out which building is the prison.
  - Park the robot in front of the prison.

2023 Final task

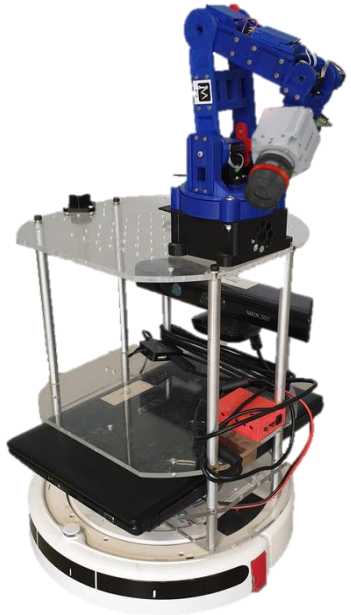


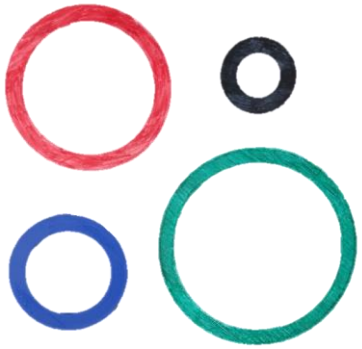


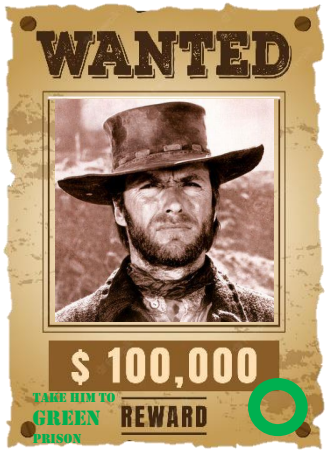
- in simulation…

2023 Final task

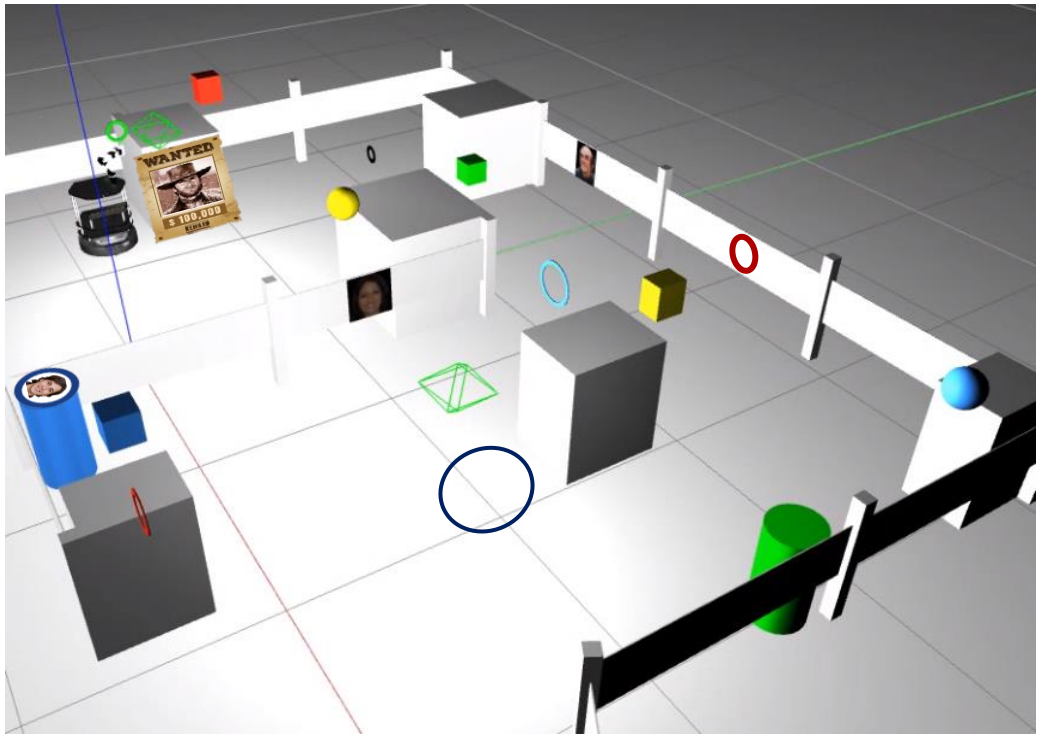






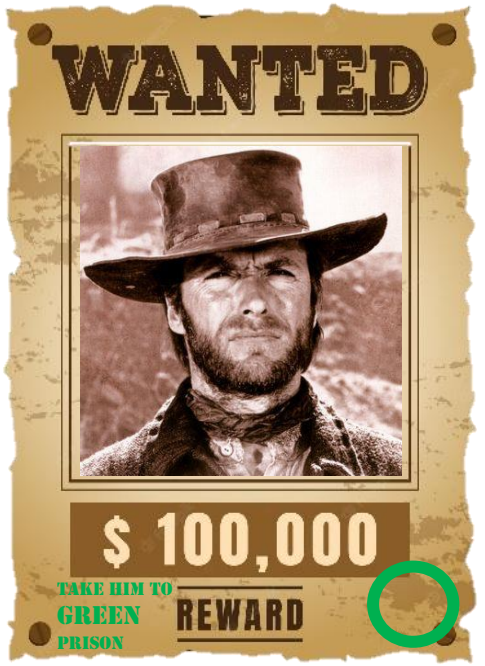
Simulated scene



- There will be faces, posters, and other objects on the walls, including printed rings
- There might be different objects in the scene at the same height as 3D rings
- Rings will not be positioned exactly above the parking place

Even more precisely

- Find all persons
  - Done for Task 1
  - The number of persons present is not known in advance
  - (Preferably) implement the autonomous exploration of space
- Find the posters, decide which robbers to find, and determine where to take them
  - Detect posters
    - By detecting faces appearing on posters, or poster design
    - Make sure to differentiate between persons and posters
    - Remember the face depicted
  - Recognize the award offered
    - Using OCR, digit classifications, etc.
  - Determine the colour of the ring denoting the prison cylinder
    - Determine the colour of the ring depicted on the poster or
    - determine the colour of the text or
    - recognise the word describing the colour of the ring

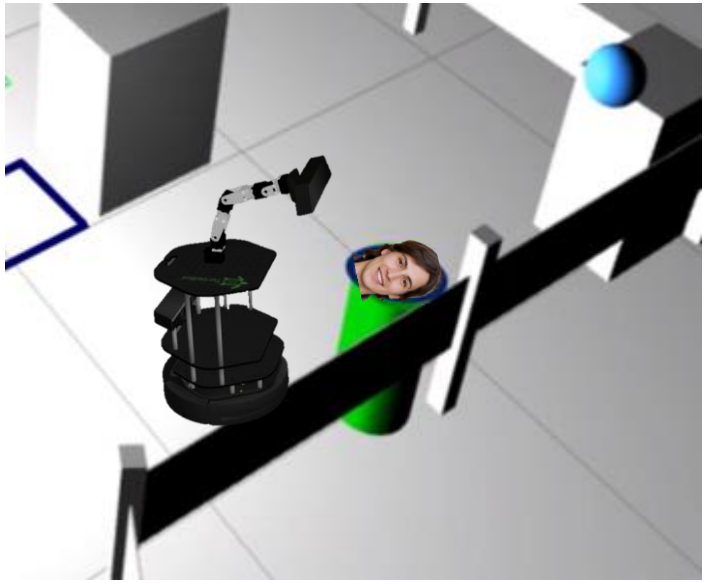


Even more precisely

- Have a dialogue with the persons to determine the potential hiding places
  - Approach a person
  - Ask him about the colours of the cylinders the robbers are potentially hiding on top of
  - Implement a simple dialogue:
    - R: „Do you know where the robber is hiding?“
    - H1: „No, I don‘t.“
    - R: „Do you know where the robber is hiding?“
    - H2: „Maybe on the top of the blue cylinder. Or on the top of the red one.“
    - R: „OK. Thank you.“
  - One of the persons can give a useful hint, the rest of them know nothing.
  - The hint always includes two cylinders.
  - Simple speech synthesis
  - Simple speech recognition, limited vocabulary
    - Automatic speech recognition
    - (Or text input as a backup)

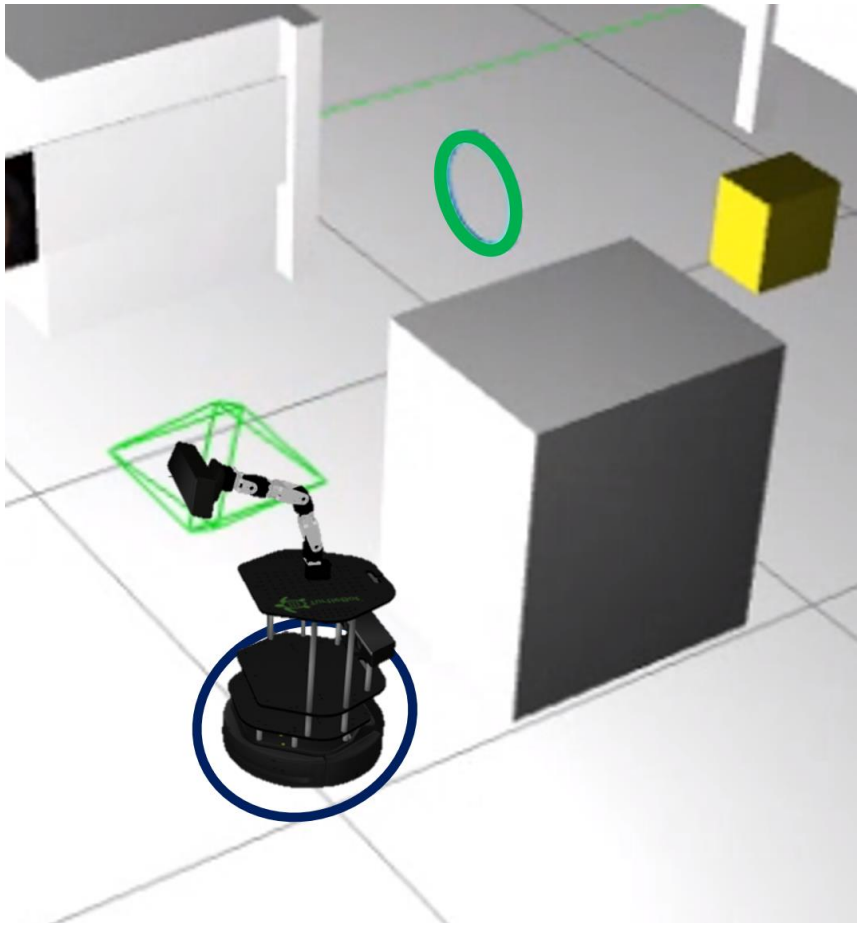
Even more precisely

- Find the robber
  - Detect the cylinders
  - Recognise their colours
  - Approach the cylinders of interest
  - Look on top of them using the camera on the robot manipulator
    - the robot is allowed to look on the top of only the cylinders it was told to
  - Detect the faces
  - Find out, which of the faces corresponds to the face on the poster
    - Using face reidentification
    - or classification
    - or image retrieval
  - Tell the robber to enter the robot car



Even more precisely

- Find the prison and park
  - Detect the rings
  - Recognise their colours to determine the prison
  - Park in the parking slot below the corresponding ring
  - Done for Task 2
  - The parking slot will not be positioned exactly under the ring
  - Say „I'm done!".
  - Wave with the manipulator.



Shortcuts

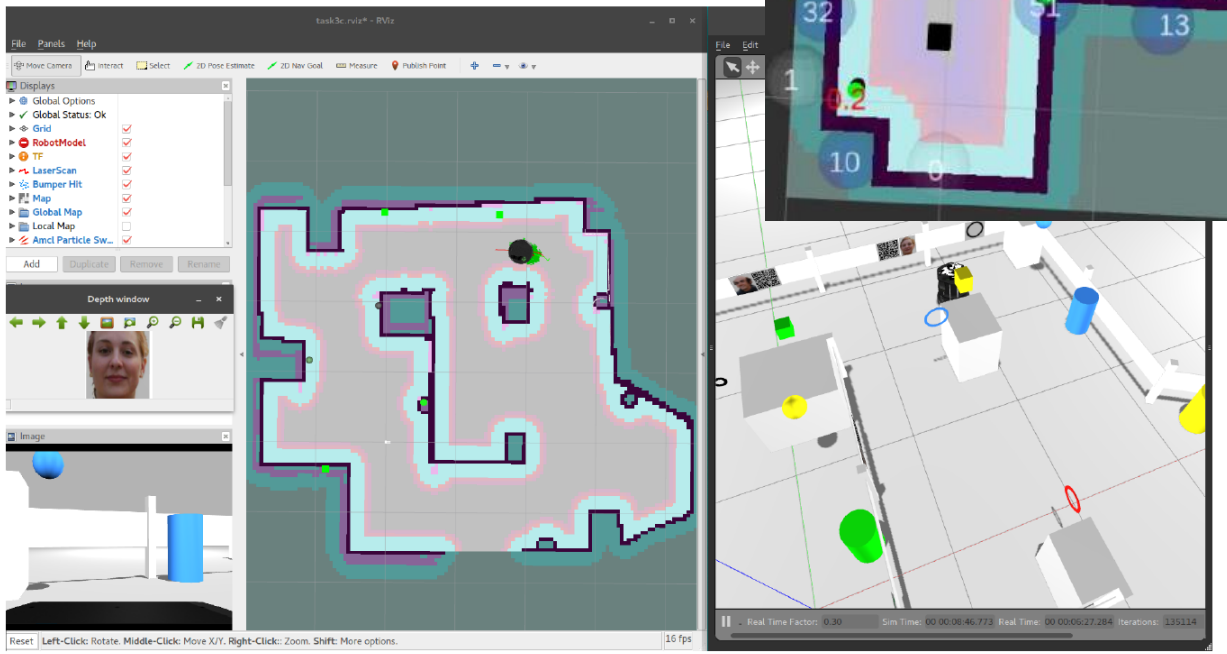
- You may not implement all the functionalities (for a lower grade)
- You may not implement the autonomous exploration of space
  - and can use fixed goals instead.
- The robot may avoid recognising the digits on the poster
  - and randomly select the robber to go after.
- The robot may skip determining which ring represents the prison
  - and use the colour written in the QR code.
- The robot can skip the dialogue with a person
  - and read the colours written in the QR code.
- You may not implement the face reidentification
  - and read the colour of the correct cylinder in the QR code.
- The QR code will therefore include all necessary information in a simple format:

```
ring blue
cylinder red
cylinder green
face green
```

Demonstration

- Demonstrate what is going on in the robot
- Visualize in RViz:
  - Locations of detected cylinders, rings, faces, posters
  - Recognised colours
  - Navigation goals, path plans
  - Current sensor readings (images, Lidar)
  - Show live strem from both cameras
- Show dialogue in a separate window
- Show the reasoning process
- Show also the current environment in Gazebo

R: „Do you know where the robber is hidding?“
H: „No, I don‘t.“
R: „Do you know where the robber is hidding?“
H: „Maybe on the top of the blue cylinder. Or on the top of the red one.“
R: „OK. Thank you.“



Tasks

- System setup
  - Running ROS
  - Tele-operating TurtleBot
- Autonomous navigation
  - Autonomous control of the mobile platform
  - Acquiring images and 3D information
  - Simultaneous mapping and localization (SLAM)
  - Path planning, obstacle avoidance, approaching
  - Advanced fine manoeuvring and parking
  - Intelligent navigation and exploration of space
- Advanced perception and cognitive capabilities
  - Detection of faces, circles, 3D rings, posters, 3D cylinders
  - Recognition of digits, colour, reidentification
  - Basic manipulation and visual servoing
  - Speech synthesis, speech recognition, dialogue processing (reading QR codes)
  - Belief maintenance, reasoning, planning

Task 1

Task 2

Task 3

Integrate everything into a robust coherent system

Evaluation protocol

- The evaluation course will be set up in advance
  - The main setup will not change
- The teams will be allowed to build the map in advance
- The faces, cylinders, posters, parking places and the rings will be positioned on the day of the evaluation
  - The size and colours of the cylinders and rings are known in advance
- The robot has to operate completely autonomously
  - only the initial positioning is allowed
  - (and the optional answering by typing the text)
- The robot can start at any position

- Every team will have allocated 15-20 minutes to show the performance of the robot

- The evaluation will take place in the last week of the semester

Requirements

- System setup
  - Running ROS
  - Tele-operating TurtleBot
- Autonomous navigation
  - Autonomous control of the mobile platform
  - Acquiring images and 3D information
  - Simultaneous mapping and localization (SLAM)
  - Path planning, obstacle avoidance, approaching
  - Advanced fine manoeuvring and parking
  - Intelligent navigation and exploration of space
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For 6
For + max. 2
For + max. 2

Grading

- Must do:
  - Face detection (2 pts)
  - Poster detection (2 pts)
  - Ring detection (2 pts)
  - Colour recognition (1 pt)
  - Approaching faces (1 pt)
  - Parking (2 pts)
- Should do:
  - Digit recognition (1 pt)
  - Circle or color name rec. (1pt)
  - Cylinder detection (2 pts)
  - Approaching cylinders (1 pt)
  - Taking images on top of cyl. (1 pt)
  - Face reidentification (2pt)
  - Auton. space exploration (2 pts)
  - Dialogue with ASR (2 pts)
  - Weaving with manipulator (1pt)
- Performance evaluation
  - Navigation (1 pt)
  - Reasoning (1 pt)
  - Visualisation (1 pt)
  - Robustness (1 pts)
  - Relative speed (1 pts)
  - Overall impression (2 pts)
- Points:
  - Must do: 10
  - Should do: 13
  - Performance: 7
  - Total: 30

Task 3 goals

- The main goals of the third task and evaluation are:
  - to navigate the robot around
  - to detect faces in 2D
  - to detect objects (rings and cylinders) in 3D
  - to learn and recognize colours
  - to reidentify faces
  - to learn and recognize digits
  - to do simple reasoning
  - to do simple dialogue processing
  - to plan adequate actions
  - to fine manoeuvre the robot
  - to do simple mobile manipulation
  - **to integrate all functionalities into a coherent system**