Guidelines for final project report

ITI 41920 Hands-on introduction to CPS

Høst 2022

The final report is worth 50 points, and the project presentation is also worth 50 points.

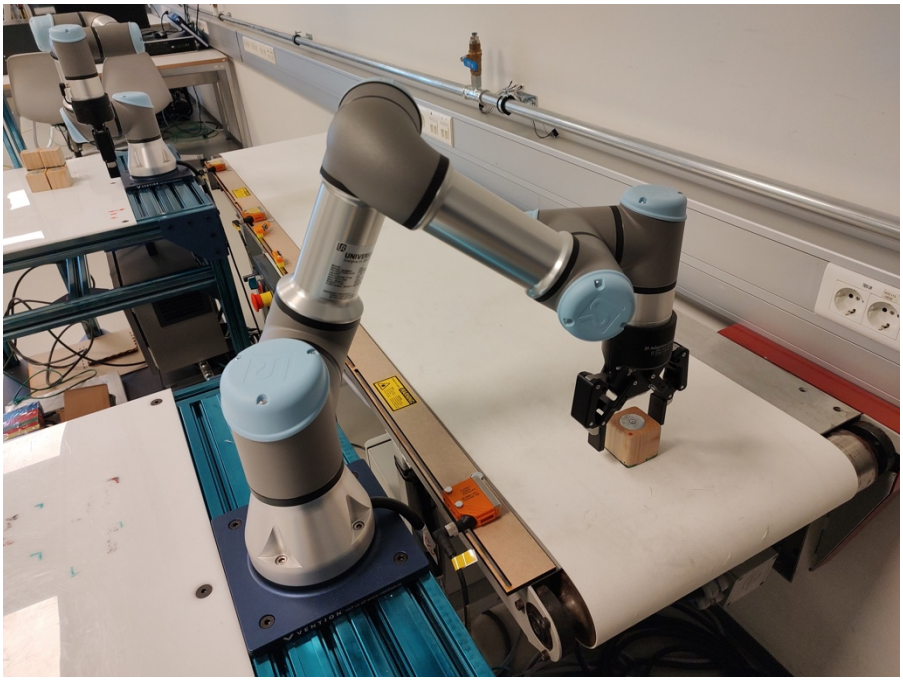
Each team should upload a single ZIP file of the project report, on the relevant link in Inspera.

Your report should be no longer than 20 pages (excluding appendices). Your report should have a date, an abstract, and the list of names of the contributors

The next two pages give information on the project expectations, and the points distribution.

Task specification for the final project:

You are given a workcell consisting of two UR3 robot arms, and a conveyor belt in between them, that are working side-by-side.



The task is to design and implement a sequencing algorithm for picking and sorting blocks.

Two types of block are to be handled: (i) cylinders, and (ii) cubes.

Home locations: You must designate one robot whitespace as the final home of the cylinders, and the other whitespace and the final home for the cubes. You should designate an edge of each whitespace, as the actual place that the homed blocks shall be placed.

The human user of your system may add these blocks at random in the white workspaces of either robot. The human is not allowed to place any blocks on the conveyor belt. The human may add blocks while your system is in operation. If the human removes any block at all, that block has to be from the home location.

Your system should sort all of the cylinders into the home edge designated for cylinders, and likewise must sort all of the cubes into the home edge for the cubes.

You should sequence your robot arm movements and conveyor belt operations in such a way that your system sorts blocks in the shortest possible time. We do not mean that the conveyor belt must be running at top speed ! What we mean is that your sequencing must be such that no unnecessary idling takes place.

Nudge allowed: The camera does not find the locations of blocks very accurately. Therefore, you are allowed to use your hand to give a slight nudge to any block if it looks like the robot arm is moving a couple of centimetres off the correct location of that block. Your nudge cannot be more than 3 cm long !

Expectations for the project report:

The purpose of the final report is to:

[6 points] give a clear problem statement:

- [3 points] describe the basic atomic actions that you shall sequence. Describe any constraints that exist, on the ways that you are allowed to sequence these atomic actions.
- [3 points] describe the requirements for your solution

[6 points] describe the Cyber and Physical parts of the whole system

- describe for example, the hardware and software functions that are given to you. For example describe the UR3´s motion primitives, stating how much time it takes to execute the commanded motion. State also how your software can know if the commanded motion has been executed.

Also for example, describe how Python´s threading/multitasking package facilitates parallel execution of atomic actions. And how it facilitates synchronization of such actions.

[10 points] describe your sequencing algorithm in detail. This should have enough detail so that a Python programmer can rely on your description and still manage to implement it.

[10 points] reason about your sequencing algorithm to prove that it meets requirements and sorts the red blocks as quickly as possibly. Give a Petri Net description of your sequencing algorithm. Show that this Petri Net is bounded, and that it is live as long as there are blocks to be picked on each picking area.

[14 points] Demonstrate the performance of your implementation. You can either upload mp4 files, or provide links to videos on Panopto – this way we do not violate GDPR regulations.

- Six blocks are placed are laid out at random locations (but not at the home edges), in each of the two picking areas. Of the six blocks in each picking area, a random number of blocks, less than six are cubes. You pass this test and you get [5 points] if all the blocks are sorted. (note: obviously this test case should not be coded into your program)
- you get another [3 points] if all the twelve blocks are sorted as quickly as possible

- you get another repeat the test case described above with the following variation: at some point in the handling of the test case, the human user adds one block at random to each whitespace. And a few seconds later, adds a third block at random. This third block should be away from the whitespace where its home lies. . You pass this test and you get [3 points] if all the blocks are sorted. you get another [3 points] if all twelve blocks are sorted as quickly as possible

[4 points] discuss how the situation in this project resembles real scenarios in factory automation