

# ABB robot Assignment 4

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## 4 Spot weld simulation

### 4.3 Simulated spot welding, RobotStudio

#### 4.3.1 RobotStudio simulation

- a) First, do simulation of the welding path given by the RAPID code included in the pack-and-go file. Make sure you understand what this simulation does and that it runs as intended on your computer. You will not be able to retrieve data about success or failure in welding yet, you only have visual control of whether the tool enclose the peg or not and if this lasts for the wanted amount of time. Run both `testPeg00()` and `test4corners()` and check that they work as intended. You can try several combinations of `doSlow`, `useFlexPendant` and `useBoardOnTable`, but at least use all these three as `TRUE`.

Done

- b) Secondly, change the `testPeg00()` function such that it use the `FlexPendant` to ask for a peg to test, a number 1 to 16 for  $(dx,dy) \in \{(0,0), (0,60), (0,120), (0,180), (1,0), \dots, (180,180)\}$ . It may be an idea to put this in a loop, quit loop if an illegal number is given, to allow for another target point after the current one is done. Check that this works, then add another option that asks for rotation in steps of  $45^\circ$  between  $-180^\circ$  and  $180^\circ$ . You should note that not all these combinations are reachable. Perhaps if additional instructions are added in some cases more target points are reachable. Find out which combinations are reachable for work object `wobjTestBoardOnTable`, a table should be filled out and included in the report.

dx dy	-180°	-135°	-90°	-45°	0°	45°	90°	135°	180°
(0, 0)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(0, 60)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(0, 120)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(0, 180)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(60, 0)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(60, 60)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(60, 120)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(60, 180)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(120, 0)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(120, 60)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(120, 120)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(120, 180)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(180, 0)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(180, 60)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(180, 120)	✓	✓	✓	✓	✓	✓	✓	✗	✓
(180, 180)	✗	✓	✓	✓	✓	✓	✓	✗	✗

- c) Finally, for the third option of the menu in the RAPID main-function call a new function `test7pegs()` similar to function `test4corners()`. Use pegs as the board layout shown in figure 5 if all these positions are reachable, if not change rotation of pegs, towards  $0^\circ$ , until the position is reachable. You should not try to change the position and orientation of the pegs on the test board in the RobotStudio station but keep the layout as it is, figure 3, and thus allow collisions during simulation. However, you should see that the robot movement is as expected. Include the used rotations for each peg, and the total time as reported on the FlexPendant in the report.

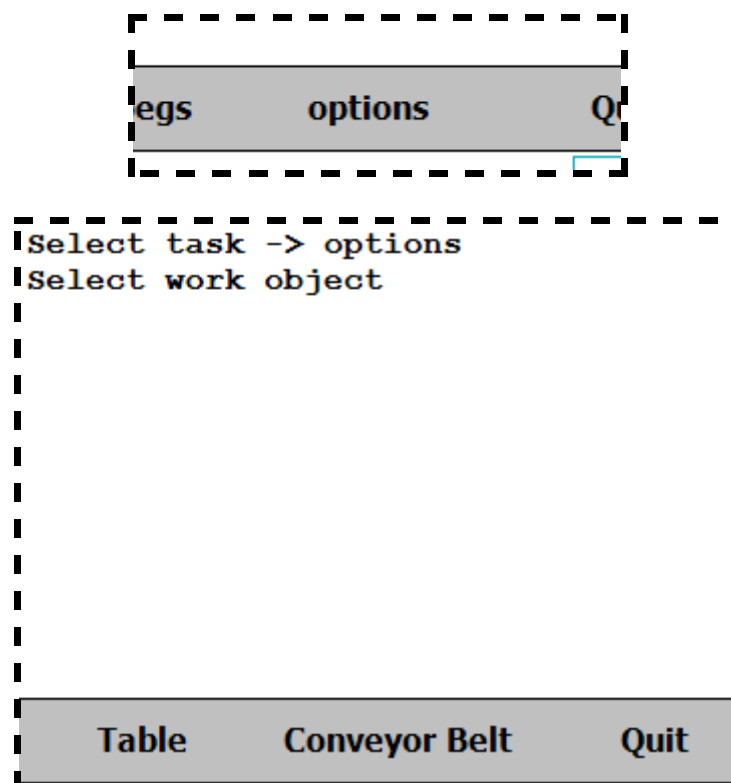
The rotations used were those proposed in Figure 5. Below is the tool's movement to reach each of the pegs (dx, dy, rotation).

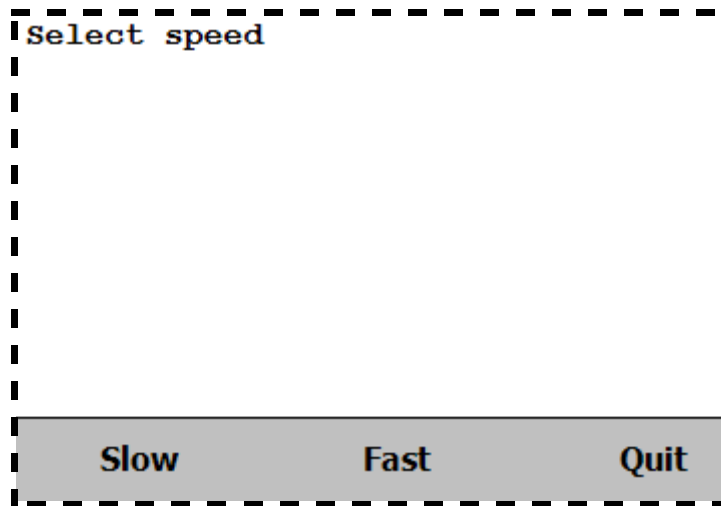
```
doPeg00 0, 180, 90; ! 1 Point
doPeg00 0, 0, 0; ! 2 Point
doPeg00 180, 0, 90; ! 3 Point
doPeg00 60, 180, -45; ! 4 Point
doPeg00 60, 60, 45; ! 5 Point
doPeg00 120, 120, 0; ! 6 Point
doPeg00 180, 120, -45; ! 7 Point
```

```
test7pegs() started
Time used on test7pegs() [s] = 10.947
```

- d) Optionally, for the fourth option of the menu in the RAPID main function call a new function `options()` that lets the operator select which work object to use, i.e. above table or above conveyor belt, and select value of `doSlow` parameter.

Done.





## 4.4 Using TATEM tool on Rudolf in UiS Lab

### - Test 4 corners simulation

When correctly centering the pegs on the table, Rudolf performs the welding test on the four corners successfully. This can be observed in the resulting report provided by the **tatemCom.py** program.

#### 1. Slow Mode:

```
This file has 4 events
Event 0 is Success    tA= 0.0    tO= 350.5    tR= 196.4 [ms] (time since first event is 0.0000 [s])
    More times      tA2= 100.2 DOon= 450.7 tR2= 196.4 Llon= 647.1 [ms]
Event 1 is Success    tA= 0.0    tO= 349.9    tR= 195.4 [ms] (time since first event is 3.4019 [s])
    More times      tA2= 100.2 DOon= 450.1 tR2= 195.4 Llon= 645.5 [ms]
Event 2 is Success    tA= 0.0    tO= 350.6    tR= 182.0 [ms] (time since first event is 6.3179 [s])
    More times      tA2= 100.2 DOon= 450.8 tR2= 182.0 Llon= 632.8 [ms]
Event 3 is Success    tA= 0.0    tO= 349.9    tR= 181.4 [ms] (time since first event is 9.1040 [s])
    More times      tA2= 100.2 DOon= 450.1 tR2= 181.4 Llon= 631.5 [ms]
Summary: 4 Success, 0 TaError, 0 NotDefined, 0 Other.
```

#### 2. Fast Mode:

```
This file has 4 events
Event 0 is Success    tA= 61.8    tO= 399.8    tR= 208.1 [ms] (time since first event is 0.0000 [s])
    More times      tA2= 100.4 DOon= 500.3 tR2= 208.1 Llon= 708.4 [ms]
Event 1 is Success    tA= 67.8    tO= 399.2    tR= 204.3 [ms] (time since first event is 3.3303 [s])
    More times      tA2= 100.4 DOon= 499.7 tR2= 204.3 Llon= 704.0 [ms]
Event 2 is Success    tA= 60.2    tO= 400.1    tR= 210.2 [ms] (time since first event is 6.2088 [s])
    More times      tA2= 100.1 DOon= 500.2 tR2= 210.2 Llon= 710.4 [ms]
Event 3 is Success    tA= 64.4    tO= 399.8    tR= 205.3 [ms] (time since first event is 8.9479 [s])
    More times      tA2= 100.3 DOon= 500.1 tR2= 205.3 Llon= 705.4 [ms]
Summary: 4 Success, 0 TaError, 0 NotDefined, 0 Other.
```

### 3. Automatic Mode:

```
This file has 4 events
Event 0 is Success    tA= 0.0    t0= 349.6    tR= 190.0 [ms] (time since first event is 0.0000 [s])
More times           tA2= 100.5    D0on= 450.0    tR2= 190.0    Llon= 640.0 [ms]
Event 1 is Success    tA= 0.0    t0= 350.1    tR= 186.3 [ms] (time since first event is 1.4197 [s])
More times           tA2= 100.1    D0on= 450.1    tR2= 186.3    Llon= 636.5 [ms]
Event 2 is Success    tA= 0.0    t0= 349.7    tR= 185.7 [ms] (time since first event is 2.8269 [s])
More times           tA2= 100.3    D0on= 450.0    tR2= 185.7    Llon= 635.7 [ms]
Event 3 is Success    tA= 0.0    t0= 350.0    tR= 187.5 [ms] (time since first event is 4.2377 [s])
More times           tA2= 100.1    D0on= 450.2    tR2= 187.5    Llon= 637.6 [ms]
Summary: 4 Success, 0 TaError, 0 NotDefined, 0 Other.
```

Additionally, we can observe that the fast mode (doSlow = FALSE) reduces the simulation's execution time. However, what truly makes a difference is running the program in automatic mode.

## - Test 7 pegs simulation

Once again, by correctly placing the pegs, Rudolf successfully runs the simulation, with execution times varying depending on the mode.

### 1. Slow Mode:

```
This file has 7 events
Event 0 is Success    tA= 0.0    t0= 349.7    tR= 190.6 [ms] (time since first event is 0.0000 [s])
More times           tA2= 100.4    D0on= 450.1    tR2= 190.6    Llon= 640.7 [ms]
Event 1 is Success    tA= 0.0    t0= 350.1    tR= 185.1 [ms] (time since first event is 6.8187 [s])
More times           tA2= 100.1    D0on= 450.2    tR2= 185.1    Llon= 635.3 [ms]
Event 2 is Success    tA= 0.0    t0= 350.1    tR= 189.7 [ms] (time since first event is 14.0635 [s])
More times           tA2= 100.1    D0on= 450.2    tR2= 189.7    Llon= 639.9 [ms]
Event 3 is Success    tA= 0.0    t0= 349.7    tR= 200.3 [ms] (time since first event is 23.8096 [s])
More times           tA2= 100.3    D0on= 450.0    tR2= 200.3    Llon= 650.3 [ms]
Event 4 is Success    tA= 0.0    t0= 350.0    tR= 184.6 [ms] (time since first event is 31.0550 [s])
More times           tA2= 100.2    D0on= 450.2    tR2= 184.6    Llon= 634.7 [ms]
Event 5 is Success    tA= 0.0    t0= 350.0    tR= 200.2 [ms] (time since first event is 34.9379 [s])
More times           tA2= 100.2    D0on= 450.2    tR2= 200.2    Llon= 650.4 [ms]
Event 6 is Success    tA= 0.0    t0= 350.0    tR= 183.7 [ms] (time since first event is 39.0548 [s])
More times           tA2= 100.2    D0on= 450.2    tR2= 183.7    Llon= 633.9 [ms]
Summary: 7 Success, 0 TaError, 0 NotDefined, 0 Other.
```

### 2. Fast Mode:

```
This file has 7 events
Event 0 is Success    tA= 45.0    t0= 399.5    tR= 225.7 [ms] (time since first event is 0.0000 [s])
More times           tA2= 100.4    D0on= 499.9    tR2= 225.7    Llon= 725.6 [ms]
Event 1 is Success    tA= 35.7    t0= 399.8    tR= 232.2 [ms] (time since first event is 6.7662 [s])
More times           tA2= 100.4    D0on= 500.1    tR2= 232.2    Llon= 732.3 [ms]
Event 2 is Success    tA= 40.0    t0= 399.9    tR= 225.1 [ms] (time since first event is 13.9640 [s])
More times           tA2= 100.3    D0on= 500.1    tR2= 225.1    Llon= 725.2 [ms]
Event 3 is Success    tA= 37.3    t0= 399.9    tR= 229.7 [ms] (time since first event is 23.6577 [s])
More times           tA2= 100.3    D0on= 500.2    tR2= 229.7    Llon= 729.9 [ms]
Event 4 is Success    tA= 40.4    t0= 399.6    tR= 227.9 [ms] (time since first event is 30.8407 [s])
More times           tA2= 100.5    D0on= 500.1    tR2= 227.9    Llon= 728.0 [ms]
Event 5 is Success    tA= 40.2    t0= 399.7    tR= 231.6 [ms] (time since first event is 34.6635 [s])
More times           tA2= 100.5    D0on= 500.2    tR2= 231.6    Llon= 731.8 [ms]
Event 6 is Success    tA= 42.0    t0= 399.7    tR= 230.7 [ms] (time since first event is 38.7203 [s])
More times           tA2= 100.5    D0on= 500.2    tR2= 230.7    Llon= 730.8 [ms]
Summary: 7 Success, 0 TaError, 0 NotDefined, 0 Other.
```

### 3. Automatic Mode:

```

This file has 7 events
Event 0 is Success    tA= 48.3  t0= 399.6  tR= 237.9 [ms] (time since first event is 0.0000 [s])
More times           tA2= 100.5  D0on= 500.1  tR2= 237.9  Llon= 738.0 [ms]
Event 1 is Success    tA= 46.5  t0= 399.9  tR= 234.9 [ms] (time since first event is 1.4061 [s])
More times           tA2= 100.3  D0on= 500.2  tR2= 234.9  Llon= 735.1 [ms]
Event 2 is Success    tA= 49.3  t0= 400.1  tR= 239.4 [ms] (time since first event is 2.8569 [s])
More times           tA2= 100.0  D0on= 500.2  tR2= 239.4  Llon= 739.6 [ms]
Event 3 is Success    tA= 47.6  t0= 399.9  tR= 239.1 [ms] (time since first event is 4.4222 [s])
More times           tA2= 100.3  D0on= 500.2  tR2= 239.1  Llon= 739.3 [ms]
Event 4 is Success    tA= 49.0  t0= 399.8  tR= 251.1 [ms] (time since first event is 5.8408 [s])
More times           tA2= 100.4  D0on= 500.2  tR2= 251.1  Llon= 751.2 [ms]
Event 5 is Success    tA= 47.0  t0= 399.7  tR= 242.3 [ms] (time since first event is 7.0798 [s])
More times           tA2= 100.4  D0on= 500.2  tR2= 242.3  Llon= 742.4 [ms]
Event 6 is Success    tA= 48.3  t0= 400.2  tR= 239.8 [ms] (time since first event is 8.3078 [s])
More times           tA2= 100.1  D0on= 500.3  tR2= 239.8  Llon= 740.1 [ms]
Summary: 7 Success, 0 TaError, 0 NotDefined, 0 Other.

```

Just like before, we can observe how the fast mode reduces the execution time, and the automatic mode once again makes a significant difference.

## Working hours

Date	Time	Student working
October 17th	LAB: 11:30 - 15:45	Anton & Daniel
October 18th	LAB: 10:00 - 15:00	Anton & Daniel