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Performance Comparison Between Collaborative and Industrial Robots: A Study Using Digital Twins of Robotic Cells

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Introduction

Digital twins are increasingly being used for dynamic production in the industry 4.0.

Cyber physical systems

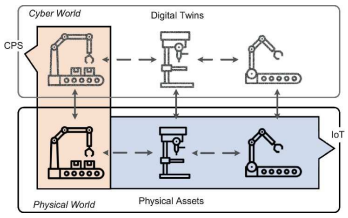

Figure 1. Esquematization of comunication between physical and virtual environments

Robot models used for the two digital twins

Figure 2. LR Mate200iD robot model used as an industrial robot reference..

Figure 3. CRX-10iA COBOT model used as a collaborative robot reference

Research objectives

- Validate the diferences between industrial robots and collaborative robots based on cycle time performance.
- Present the process of making digital twins of a robotic cell using dedicated robot simulators.

Methods

Build the virtual environment accordingly to the physical counterparty

to guarantee the Verisimilitude of the DT, the virtual environment was made using the 3D models of the physical robotic cell components positioned identically to the physical counterparty.

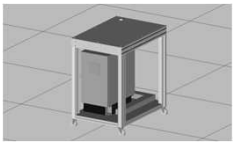

Figure 4. Workbench 3D model modelled on Inventor Professional

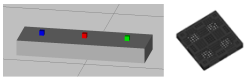

Figure 5 Blocks manipulated during the "pick and place task" task and their pallets

Figure 6. Gripper SCHUNK used by the physical robot whose movement simulation respects the physical device

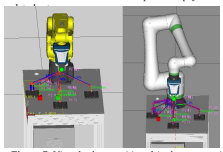

Figure 7. Virtual robots positioned in the same position of the physical robot

Simulation of the task

The simulation program allows to perform pickup and drop functions of the parts and validate the robot performance from the trajectory profile.

```
PR[ 37:                ]=*
PR[ 38:APROXout_BLUE   ]=R
PR[ 39:PLACE_BLUE      ]=R
PR[ 40:PICK_BLUE       ]=R
PR[ 41:APROXin_BLUE    ]=R
PR[ 42:PICK_RED        ]=R
PR[ 43:APROXin_RED     ]=R
PR[ 44:PICK_GREEN      ]=R
PR[ 45:APROXin_GREEN   ]=R
PR[ 48:PICK_RED        ]=R
PR[ 49:APROXin_RED     ]=R
PR[ 50:PLACE_RED       ]=R
PR[ 51:APROXout_RED    ]=R
```

Figure 8. Each block has four position registers: approach to capture, capture, approach to drop and drop.

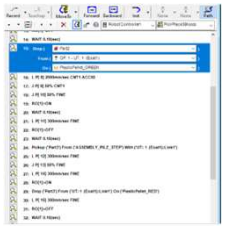

Figure 9. The "Teach" function allows the software to extract performance data

The COBOT program was made identically to the LR Mate200iD program so that any performance difference is directly related to the robot's kinematics and geometry difference.

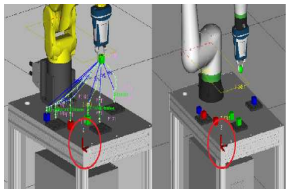

Figure 10. Common user-frame to copy the position registers from the first DT.

Results

Difference of movement configurations and speed

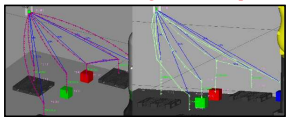

Figure 11. Difference of aerial movement discretization affects each robot's time to change positions

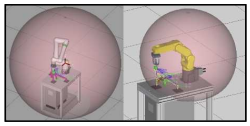

Figure 12. Difference o work envelope sizes affects the potencial configurations that each robot can take

Cycletime based on movement time between positions

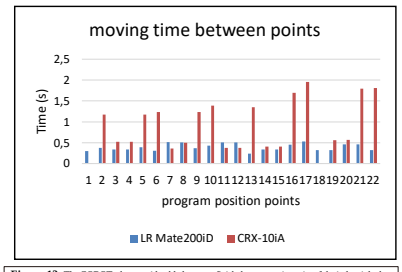

Figure 13. The COBOT takes considerably longer to finish the same trajectories of the industrial robot specially during aerial movements presenting higher variance of time values (0,007019413 0,007019413) . Industrial robots keep Moving fast with low variance of time values (0,007019413)

Conclusions

- Collaborative robots are considerably more flexible and slower compared to industrial robots fitting perfectly on applications alongside humans to best deal with the unpredictability of the operator to best perform in a changing scenario.
- While industrial robots as the consolidated type in the industry focus on more constant tasks that need to be performed faster and with a shorter path choosing cycle time reduction over flexibility.

Acknowledgement

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References

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