Industrial Robot Trajectory Generation and Execution for 3D Printing using an ABB IRB 1200

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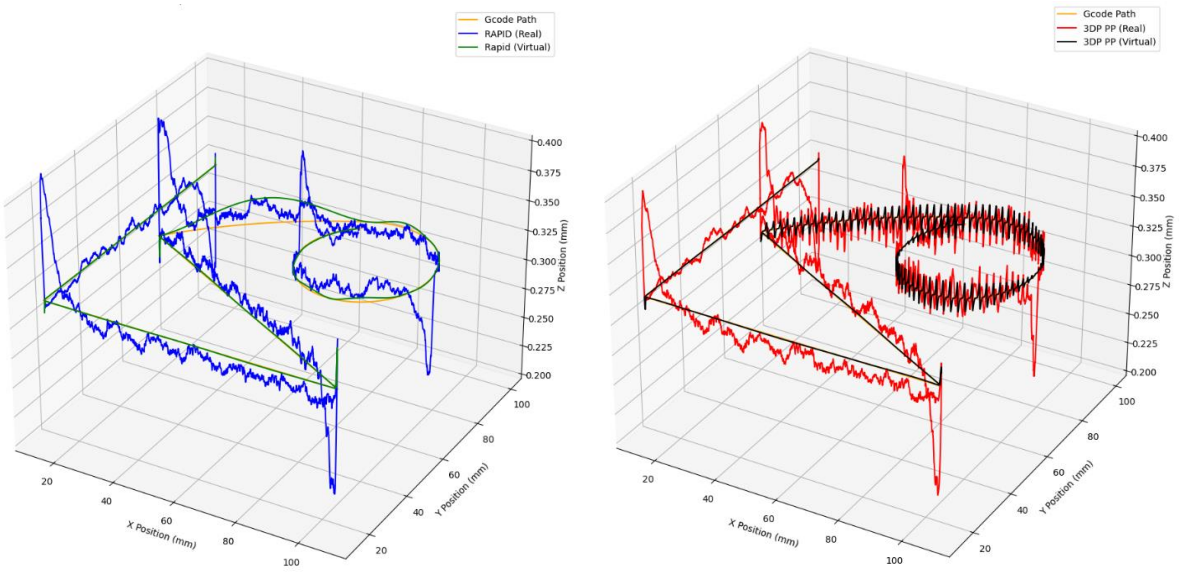
Abstract: The use of industrial robots in additive manufacturing processes has become increasingly important, offering more flexibility and the capability of multi-directional printing. This integration facilitates the production of more complex geometries, free from the limitations of small build volumes and support structures, opening new possibilities for innovation in advanced manufacturing systems. As the complexity of the printed structures grows, optimizing robot trajectories is essential to ensure high-quality results. This work presents a comparative analysis of robot trajectory generation and execution using ABB's 3D Printing Power Pack and generated RAPID coding in both simulated and real environments. The objective is to assess the use of the Power Pack in term of trajectory accuracy and efficiency, as well as how the simulated results compare with the real ones, considering the use-case of 3D printing.

To support this analysis, a "test pattern" was designed to account for different trajectories, consisting of a single line extrusion path featuring long linear segments, corners, and curved sections. The path was converted into both G-code and RAPID code. The G-code was first validated on a standard 3D printer and then used as input in the 3D Printing Power Pack application to generate a RAPID program for the robot. Separately, another RAPID program was created manually to execute the same path, based on the G-code. Both programs were executed on a simulated environment in RobotStudio, and on an ABB IRB 1200 robot. Throughout the tests, the robot's Tool Center Point (TCP) position was captured using ABB's Externally Guided Motion (EGM) application.



The collected data was analyzed to determine the position errors by comparing the executed paths to the intended trajectory, considering the Euclidean distance from each captured and position to the desired path. The results indicate that the program generated by the 3D Printing Power Pack performed similarly to the RAPID program in straight segments and corners but exhibited slightly higher errors in the curved sections. This discrepancy is likely due to the G-code discretization process, where arc movements (G2) had to be converted into linear movements (G1), as the Power Pack does not support arc commands. Different orientations were also tested, and its results analyzed.

The results are of extreme importance regarding the decision of the methods to use in future 3D printing processes using ABB's industrial robots.

Keywords: Additive Manufacturing; Industrial Robot Manipulator; Robot Trajectory Generation and Execution.

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