A Model of Parallel Kinematics for Machine Calibration

Parallel kinematics have been adopted by more than 25 manufacturers of high-end desktop 3D printers [Wohlers Report (2015), p.118] as well as by research projects such as the WASP project [WASP (2015)], a 12 meter tall linear delta robot for Additive Manufacture of large-scale components for construction engineering applications. The parallel kinematics of a linear delta robot has the potential to out-complete Cartesian point-based deposition systems with respect of acceleration and thus repositioning speeds since the primary movable mass in these types of systems can be kept to a minimum. This research identifies that the rapid lift and repositioning capabilities of delta robots can reduce defects on extruded 3D printed parts when compared to traditional Cartesian motion systems. This is largely due to the fact that repositioning is so rapid that the extruded strand is instantly broken, and that repositioning can be completed before material oozing from the extruder can occur. The aim will be to address one of the primary disadvantages to parallel kinematics systems.

Calibration and geometrical validation. Calibration of a delta robot can be a source of frustration. This research aims to provide the operator with a strong tool for easing this task. The kinematics and calibration of delta robots, in particular, are less researched than that of traditional Cartesian robots, for which tried-and-true methods for calibrating are well known. A forwards and reverse virtual model of a delta robot has been developed in order to decompose the different types of geometrical errors into 6 elementary cases. Deliberate introduction of errors to the virtual machine has subsequently allowed for the generation of deviation plots that can be used as a strong tool for the identification and correction of geometrical errors on a physical machine tool.