Optimizing the Build Parameters of a Linear Delta Robot

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Linear Delta robots (LDRs) are a relatively new subset of parallel robots, used in some 3D printing and manufacturing applications due to their rigidity and speed. However, there are just two common designs used in the vast majority of LDR applications. Prior studies about synthesizing optimal LDR designs have been limited to 2 dimensions, or were constrained by symmetry. Thus, this algorithm was built with the purpose of generating LDR designs that optimally cover a specified workspace in order to explore the possibilities of asymmetric and nonstandard designs. The algorithm defines the fitness of an arbitrary LDR design through three metrics: material cost, volume deviation, and global dexterity index. In order to calculate the latter two metrics, a novel method of determining the workspace of an LDR was established. The algorithm defines an LDR's workspace through the intersections, unions, and differences of simple geometric components: cylinders and spheres. Then, the boundaries of the workspace are determined by projecting vectors from the origin and using line intersection formulas to find the maximum extent of the workspace along each vector's span. These are used as integration bounds to find the volume deviation and global dexterity index of an LDR design, allowing the fitness to be evaluated. This fitness function is then minimized using particle swarm optimization. The algorithm was effective in generating LDR designs that covered the specified workspaces well, including asymmetrical designs that outperformed standard symmetrical ones. Thus, it could open new avenues of asymmetrical LDR design and extend LDRs' applications.

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