GPU Accelerated Process Planning For CNC-Machined Parts: Industrial Components to Bone Implants

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Introduction

For manufacturing a part using conventional 3-Axis CNC machining process, one must determine a set of machining orientations. Generally this process planning task is carried out manually by the machinist, considering decision parameters such as part visibility, machinability, machining depths, tool geometry, etc. In this work, we modelled this as a Linear optimization problem; the solution to which is a set of machining orientations. The solution methodology employs a Greedy algorithm and a Heuristic Simulated Annealing (SA) approach in order to get a globally optimal solution set of machining orientations. Generally this process planning task is carried out manually by the machinist, considering decision parameters such as Tool Length (inch) used within a given d and Machinability from a θ_i within a given d.

Objective Function (Obj F) & Variables

Min (f(θ_0, θ_1, ..., θ_n)) = \sum_{d=0}^{10} (θ(D)_d) + α (% NV) + β (% NM) + γ (% R) + δ (θ_0

Solution Methodology (Greedy + SA)

Objective

The objective of this work is to provide automated process planning for advanced manufacturing systems, specifically to this, to determine an optimal set of orientations to create a part using CNC machining.

Machined Samples

Results: GPU: Tesla-C2075/CPU: 2.90GHz, 32GB RAM

Conclusions

As the model dimensions increase, the total processing times are dramatically shorter using (GPU + CPU) vs CPU. Implementing the algorithms on the GPU allows more extensive analysis, whereby multiple manufacturability and process capabilities can be considered, while yielding better solutions faster.

References


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