Machining Parameter Optimization for the Specified Surface Conditions : An Approach using Genetic Algorithm and Simulated Annealing

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Abstract

To maximize production rate of machining while satisfying the surface conditions on the machined product is very important, because the surface quality decides the component performance, longevity, and reliability. The perfectness of machined surface is determined by the surface integrity, which is related to the surface roughness, hardness variation, structural change, and residual stress. Therefore, the ability to achieve a specified surface roughness and residual stress distribution on the machined surface is a necessary objective of the machining process. It is also very important to get stable and quick optimal values of machining conditions in order to provide reliable feed back to the adaptive optimal control of machining process in real time. Using the developed computer-based simulation models to identify machining states, this paper presents a general and reliable procedure to select machining parameters for a given machine tool, which provides the maximum metal removal rate for any specified surface quality and tool life. This machining optimization can be formulated as solving an optimization problem which has many local extreme and does not have a smooth global optimum point. Generally, the global optimal solution for such a problem is hard to find using conventional iterative improvement algorithm because it is usually trapped at a local minimum. Thus, reliable and effective methods called as simulated annealing and genetic algorithm were applied to obtain the global optimum in this paper. These methods could attract significant attention due to suitability to the optimization problems of large scale, especially when a desired global extremum is hidden among many poorer and local extrema. Numerical results showed that the approach could be used to reach the quick and reliable optimization value and had considerable advantage in specifying the machining variables to achieve the stated objective.