Abstract

To ensure quality of machined products at minimum machining costs and maximum machining effectiveness, it is very important to select optimum parameters when metal cutting machine tools are employed. Traditionally, the experience of the operator plays a major role in the selection of optimum metal cutting conditions. However, attaining optimum values each time by even a skilled operator is difficult. The non-linear nature of the machining process has compelled engineers to search for more effective methods to attain optimization. The design objective preceding most engineering design activities is simply to minimize the cost of production or to maximize the production efficiency. The main aim of research work reported here is to build robust optimization algorithms by exploiting ideas that nature has to offer from its backyard and using it to solve real world optimization problems in manufacturing processes.

In this thesis, after conducting an exhaustive literature review, several optimization techniques used in various manufacturing processes have been identified. The selection of optimal cutting parameters, like depth of cut, feed and speed is a very important issue for every machining process. Experiments have been designed using Taguchi technique and dry turning of SS420 has been performed on Kirlosker turn master 35 lathe. Analysis using S/N and ANOVA were performed to find the optimum level and percentage of contribution of each parameter. By using S/N analysis the optimum machining parameters from the experimentation is obtained.

Optimization algorithms begin with one or more design solutions supplied by the user and then iteratively check new design solutions, relative search spaces in order to achieve the true optimum solution. A mathematical model has been developed using response surface analysis for surface roughness and the model was validated using published results from literature.

Methodologies in optimization such as Simulated annealing (SA), Particle Swarm Optimization (PSO), Conventional Genetic Algorithm (CGA) and Improved Genetic Algorithm (IGA) are
applied to optimize machining parameters while dry turning of SS420 material. All the above
algorithms were tested for their efficiency, robustness and accuracy and observe how they often
outperform conventional optimization method applied to difficult real world problems. The SA,
PSO, CGA and IGA codes were developed using MATLAB. For each evolutionary algorithmic
method, optimum cutting conditions are provided to achieve better surface finish.

The computational results using SA clearly demonstrated that the proposed solution procedure is
quite capable in solving such complicated problems effectively and efficiently. Particle Swarm
Optimization (PSO) is a relatively recent heuristic search method whose mechanics are inspired
by the swarming or collaborative behavior of biological populations. From the results it has been
observed that PSO provides better results and also more computationally efficient.

Based on the results obtained using CGA and IGA for the optimization of machining process, the
proposed IGA provides better results than the conventional GA. The improved genetic algorithm
incorporating a stochastic crossover technique and an artificial initial population scheme is
developed to provide a faster search mechanism.

Finally, a comparison among these algorithms were made for the specific example of dry turning
of SS 420 material and arriving at optimum machining parameters of feed, cutting speed, depth
of cut and tool nose radius for minimum surface roughness as the criterion. To summarize, the
research work fills in conspicuous gaps between research prototypes and industry requirements,
by simulating evolutionary procedures seen in nature that optimize its own systems.