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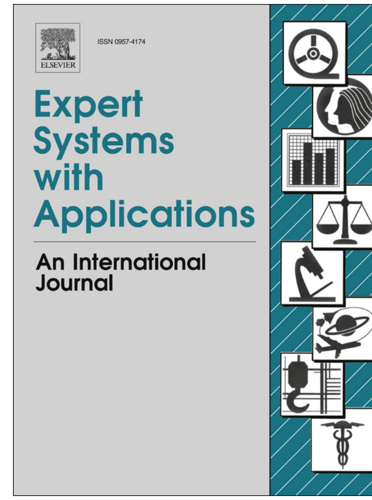

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SOFTWARE PROTOTYPE FOR VALIDATION OF MACHINING OPTIMIZATION SOLUTIONS OBTAINED WITH META-HEURISTIC ALGORITHMS

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Abstract Optimization of machining processes is of primary importance for increasing machining efficiency and economics. Determining optimal values of machining parameters is performed by applying optimization algorithms to mathematical models of relationships between machining parameters and machining performance measures. In recent years, there has been an increasing trend of using empirical models and meta-heuristic optimization algorithms. The use of meta-heuristic optimization algorithms is justified because of their ability to handle highly non-linear, multi-dimensional and multi-modal optimization problems. Meta-heuristic algorithms are powerful optimization tools which provide high quality solutions in a short amount of computational time. However, their stochastic nature creates the need to validate the obtained solutions. This paper presents a software prototype for single and multi-objective machining process optimization. Since it is based on an exhaustive iterative search, it guarantees the optimality of determined solution in given discrete search space. The motivation for the development of the presented software prototype was the validation of machining optimization solutions obtained by meta-heuristic algorithms. To analyze the software prototype applicability and performance, six case studies of machining optimization problems, both single and multi-objective, were considered. In each case study the optimization solutions that had been determined by past researchers using meta-heuristic algorithms were either validated or improved by using the developed software prototype.

Keywords: machining, optimization, meta-heuristic algorithms, exhaustive iterative search

1. INTRODUCTION

Machining is one of the most important and widely used manufacturing processes. The technology of machining has grown substantially over time owing to the contribution from many branches of engineering with a common goal of achieving higher process efficiency (Mukherjee & Ray, 2006). Among many types of machining processes, the advancement of technology and the development of many hard-to-machine materials has led to the increasing usage of newer machining processes, known as non-conventional machining processes. All these machining processes have their own machining parameters, i.e. input variables, and performance measures (responses), i.e. outputs. For an effective utilization of the machining processes, it is very important to determine the optimal values of machining parameters to achieve an enhanced machining performance with high dimensional accuracy (Samanta & Chakraborty, 2011). Furthermore, as noted by Yildiz (2009a), finding optimal values of machining parameters is a crucial task in order to minimize the machining costs and gain competitive advantage on the market.

Determining optimal values of machining parameters is required to be undertaken in two stages (Mukherjee & Ray, 2006): mathematical modeling and optimization. Modeling studies in machining are scientific ways to study system behaviors and help us to get a better understanding of this complex process. A mathematical model of a machining process is the relationship between input variables and outputs which is represented in terms of mathematical equation(s). Mathematical modeling of machining processes is based on well-known scientific principles. Basically, mathematical models can be divided into two categories: mechanistic (analytical) and empirical (Box & Draper, 1987). Complex relationships between machining parameters and responses make it difficult to generate explicit analytical models of machining processes (Zain, Haron, & Sharif, 2011; Karpat & Özel, 2007). Many analytical models involve simplifications and approximations in relation to the real machining process and do not take into account any imperfections of the machining process. Therefore, analytical models are generally not accurate enough for practical usage (Davim, 2001). Empirical models which are less general, but more accurate, have become a preferred trend for

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