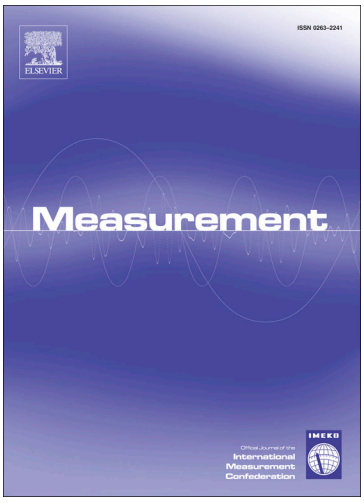

A hybrid approach to multi response optimization of micro milling process parameters using Taguchi method based graph theory and matrix approach (GTMA) and utility concept

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A hybrid approach to multi response optimization of micro milling process parameters using Taguchi method based graph theory and matrix approach (GTMA) and utility concept

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Abstract
Nowadays, it is required to produce micro products with high dimensional accuracy to use them in different applications like aerospace, electronic and optics. The objective of this study is to investigate influence of process parameters on surface roughness (Ra and Rq), tool wear and cutter vibration in micro milling of AISI304 stainless steel. According to orthogonal array of L27, twenty seven experiments were conducted on the workpiece with carbide end mill cutter at different levels of spindle speeds, feeds and depth of cuts. A hibrid approach of Taguchi method based graph theory and matrix approach (GTMA) and utility concept was used for multi response optimization of process parameters. The GTMA was used to calculate weightage of four responses as per user's opinion or preference. The utility concept was used to calculate utility value of four responses using preference scale. Mean utility values of responses are analyzed with Taguchi method and analysis of variance. The optimum process parameters for the minimization responses were found to be 6000rpm of spindle speed, 95 µm/teeth of feed and 50µm of depth of cut. The predicted responses at optimal process parameters are Ra= 0.534µm, VB = 70.861 µm, Amp = 54.395µm and Rq = 0.894µm. A confirmation test was also carried out to verify the results.

Keywords: Micro milling, GTMA, Utility concept, Taguchi method, tool vibration, Optimization

1. Introduction

Micro milling is a micro mechanical machining process suitable for production of micro components with high dimensional accuracy [1]. Micro scale components used in biomedical devices, micro sensors etc. are made with polymer by microinjection molding process in mass production [2]. Micro dies and moulds used in the microinjection molding are made by micro machining with good dimensional accuracy and surface quality [1]. Alternate methods like electric discharge machining and micro laser milling are also used to make micro molds and dies but the metal removal rate and surface quality were found to be less than micro milling [3]. Micro end milling is capable of fabricating three dimensional complex components on different type of materials. Due to its versatility, high material removal rate, low setup cost, and ease of use, the micro milling became best alternate fabricating method [4].

There are two difficulties in micro milling viz formation of burrs and rapid tool wear in machining of hard metals. Formation of burrs on machined components is the most unfavorable tendency that affects the functionality of component. In addition to that, there is rapid tool wear that also affects the surface quality and tool life [5]. Tool condition monitoring is one technique used to reduce tool wear and surface roughness by selection of optimum process parameters. Tool vibration is one of the important factors that directly affect tool wear and surface quality [6]. Most studies focused on vibration of tool in turning and work piece vibration in milling and drilling. Accelerometers were used in these studies to measure vibration of tool in turning and