Optimization of process performance by multiple pentagon fuzzy responses: Case studies of wire-electrical discharge machining and sputtering process

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ABSTRACT

This research developed mathematical models to optimize process performance for multiple pentagon fuzzy quality responses. Initially, each quality response was represented by a pentagon membership function. Then, the combination of optimal factor levels was obtained for each response replicate. Those optimal combinations were then used to construct pentagon regression models for each response. A pentagon fuzzy optimization model was formulated and solved to determine the combination of optimal factor levels at each element of pentagon response's fuzzy number. Two real case studies, i.e. wire-electrical discharge machining and sputtering process, were provided for illustration. Optimal results of the two case studies revealed that the proposed procedure effectively optimized performance under uncertainty and provided larger improvement in multiple quality characteristics. In conclusion, the proposed procedure may enhance the process engineer's knowledge about effects of uncertainty on process/product performance and help practitioners decide the proper adjustments of factor levels in order to enhance performance of electrical discharge machining and sputtering process.

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Optimizacija zmogljivosti procesa z različnimi peterokotnimi mehкими odzivi: Študiji primera postopkov obdelave z žično elektroerozijo in postopkom naprševanja

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POVZETEK

Ta raziskava je razvila matematične modele za optimizacijo zmogljivosti procesa z različnimi peterokotnimi mehкими odzivi. Sprva je bil vsak odziv predstavljen s funkcijo članstva v peterokotniku. Nato je bila za vsako ponovitev odziva pridobljena kombinacija optimalnih ravni dejavnikov. Te optimalne kombinacije so bile nato uporabljene za izdelavo peterokotnih regresijskih modelov za vsak odziv. Oblikovan in rešen je bil model peterokotne mehke optimizacije, s čimer se določi kombinacija optimalnih ravni dejavnikov pri vsakem elementu mehkega števila odziva peterokotnika. Za ponazoritev sta bili predloženi dve resnični študiji primera, in sicer obdelava z žično elektroerozijo in postopek naprševanja. Optimalni rezultati obeh študij so pokazali, da je predlagani model učinkovito optimiziral delovanje obeh procesov in kljub negotovosti zagotovil izboljšanje številnih kazalnikov kakovosti. Predlagani postopek lahko izboljša znanje procesnega inženirja o vplivih negotovosti na uspešnost procesa/izdelka in pomaga izvajalcem pri odločanju o ustreznih nastavitvah ravni dejavnikov za izboljšanje učinkovitosti postopkov obdelave z žično elektroerozijo in naprševanja.

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PODATKI O ČLANKU

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Peterokotno regresijsko modeliranje;
Peterokotna mehka števila;
Žična elektroerozija (WEDM);
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Stopnja odstranjevanja materiala (MRR);
Postopek naprševanja;
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