Particle swarm optimization approach for modelling a turning process

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ABSTRACT

This paper proposes the modelling of a turning process using particle swarm optimization (PSO). The independent input machining parameters for the modelling were cutting speed, feed rate, and cutting depth. The input parameters affected three dependent output parameters that were the main cutting force, surface roughness, and tool life. The values of the independent and dependent parameters were acquired by experimental work and served as knowledge base for the PSO process. By utilizing the knowledge base and the PSO approach, various models could be acquired for describing the cutting process. In our case, three different polynomial models were obtained: models a) for the main cutting force, b) for surface roughness, and c) for tool life. All the models had exactly the same basic polynomial form which was chosen similarly to that in the conventional regression analysis method. The PSO approach was used for optimization of the polynomials' coefficients. Several different randomly-selected data sets were used for the learning and testing phases. The accuracies of the developed models were analysed. It was discovered that the accuracies of the models for different learning and testing data sets were very good, having almost the same deviations. The least deviation was noted for the cutting force, whilst the most deviation, as expected was for tool life. The obtained models could then be used for later optimization of the turning process.

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Modeliranje postopka struženja s postopkom optimizacije z rojem delcev

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POVZETEK

V prispevku predlagamo modeliranje postopka struženja z uporabo metode optimizacije z rojem delcev (angl. Particle Swarm Optimization – PSO). Neodvisne vhodne spremenljivke so bile hitrost odrezovanja, podajanje in globina reza, ki so vplivale na odvisne izhodne spremenljivke (glavno silo rezanja, površinsko hrapavost in življenjsko dobo orodja). Vrednosti neodvisnih in odvisnih spremenljivk smo dobili z izvedbo eksperimenta in so služile kot podatkovna baza za optimizacijo z algoritmom PSO. Z uporabo tega algoritma in podatkovne baze smo dobili različne polinomske modele, katerih obliko smo določili vnaprej in ki opisujejo postopek struženja. Modeli so določevali: a) glavno silo struženja, b) površinsko hrapavost in c) življenjsko dobo orodja. Vsi trije modeli so imeli enake polinomske oblike, vendar pa smo za razliko od konvencionalne regresijske metode, v pričujoči raziskavi določili (optimirali) polinomske koeficiente z metodo PSO. Za učenje in preizkus uspešnosti učenja smo uporabili različne naključno izbrane nabore podatkov. Analiza natančnosti napovedi modelov je pokazala, da so natančnosti zelo dobre in da imajo skoraj vse vrednosti, ki jih napovedo modeli, skoraj enaka odstopanja od eksperimentalnih podatkov. Najmanjšo odstopanje smo ugotovili pri obdelovalni sili, največjo pa pri življenjski dobi orodja. Dobljeni modeli se lahko s pridom uporabijo tudi za nadaljnje optimiranje neodvisnih spremenljivk pri postopku struženja.

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PODATKI O ČLANKU

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