

Hybrid ANFIS-Rao algorithm for surface roughness modelling and optimization in electrical discharge machining

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ABSTRACT

Advanced modeling and optimization techniques are imperative today to deal with complex machining processes like electric discharge machining (EDM). In the present research, Titanium alloy has been machined by considering different electrical input parameters to evaluate one of the important surface integrity (SI) parameter that is surface roughness R_a . Firstly, the response surface methodology (RSM) has been adopted for experimental design and for generating training data set. The artificial neural network (ANN) model has been developed and optimized for R_a with the same training data set. Finally, an adaptive neuro-fuzzy inference system (ANFIS) model has been developed for R_a . Optimization of the developed ANFIS model has been done by applying the latest optimization techniques Rao algorithm and the Jaya algorithm. Different statistical parameters such as the mean square error (MSE), the mean absolute error (MAE), the root mean square error (RMSE), the mean bias error (MBE) and the mean absolute percentage error (MAPE) elucidate that the ANFIS model is better than the ANN model. Both the optimization algorithms results in considerable improvement in the SI of the machined surface. Comparing the Rao algorithm and Jaya algorithm for optimization, it has been found that the Rao algorithm performs better than the Jaya algorithm.

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Hibridni algoritem ANFIS-Rao za modeliranje in optimizacijo površinske hrapavosti pri elektroerozijski obdelavi

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POVZETEK

Napredne tehnike modeliranja in optimizacije so danes nujne za učinkovito uporabo kompleksnih obdelovalnih procesov, kot je obdelava z elektroerozijo (EDM). Za ovrednotenje enega od pomembnih parametrov celovitosti površinske integritete (SI), tj. površinske hrapavosti Ra , je bila v tej raziskavi titanova zlitina strojno obdelana z uporabo različnih električnih vhodnih parametrov. Metodologija odzivne površine (RSM) je bila uporabljena za načrtovanje eksperimenta in za ustvarjanje učne baze podatkov. S pridobljenim naborom podatkov za učenje je bil razvit in optimiziran model umetne nevronske mreže (ANN) za Ra . Dodatno je bil za Ra razvit tudi model s prilagodljivimi nevronskimi mrežami z mehkim identifikacijskim sistemom (ANFIS). Optimizacija razvitega modela ANFIS je bila narejena z uporabo najnovejših optimizacijskih tehnik: Rao algoritma in Jaya algoritma. Različni statistični parametri, kot so povprečna kvadratna napaka (MSE), srednja absolutna napaka (MAE), koren povprečne kvadratne napake (RMSE), povprečna napaka pristranskosti (MBE) in povprečna absolutna odstotna napaka (MAPE) pokažejo, da je ANFIS model boljši od modela ANN. Oba optimizacijska algoritma omogočita znatno izboljšanje površinske integritete strojno obdelane površine. Pri primerjavi algoritma Rao in algoritma Jaya za optimizacijo je bilo ugotovljeno, da algoritem Rao deluje bolje kot algoritem Jaya.

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Ključne besede:

Obdelava z elektroerozijo (EDM);
Titanova zlitina;
Hrapavost površine;
Modeliranje;
Optimizacija;
Umetne nevronske mreže (ANN);
Prilagodljive nevronske mreže z mehkim identifikacijskim sistemom (ANFIS);
Rao algoritem;
Jaya algoritem

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