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Surface roughness assessing based on digital image features

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ABSTRACT

The paper gives an account of the machined surface roughness investigation based on the features of a digital image taken subsequent to the technological operation of milling of aluminium alloy Al6060. The data used for investigation were obtained by mixed-level factorial design with two replicates. Input variables (factors) are represented by the face milling basic machining parameters: spindle speed (at five levels: 2000; 3500; 5000; 6500; 8000 rev/min, respectively), feed per tooth (at six levels: 0.025; 0.1; 0.175; 0.25; 0.325; 0.4 mm/tooth, respectively) and depth of cut (at two levels: 1; 2 mm, respectively). Output variable or response is the most frequently used surface roughness parameter – arithmetic average of the roughness profile, *Ra*. Digital image of the machined surface is provided for every test sample. Based on experimental design and obtained results of roughness measuring, a base has been created of input data (features) extracted from digital images of the samples' machined surfaces. This base was later used for generating the fuzzy inference system for prediction of the surface roughness using the adaptive neuro-fuzzy inference system (ANFIS). Assessing error, i.e. comparison of the assessed value *Ra* provided by the system with real *Ra* values, is expressed with the normalized root mean square error (NRMSE) and it is 0.0698 (6.98 %).

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Ocenitev površinske hrapavosti na osnovi lastnosti digitalnih slik

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POVZETEK

V prispevku je podana raziskava površinske hrapavosti na osnovi digitalnih slik, ki so bile zajete po tehnološki operaciji rezkanja preizkušanca iz zlitine Al6060. Podatki, ki so bili uporabljeni pri raziskavi, so bili dobljeni s faktorskim načrtom, in sicer z različnimi vrednostmi (nivoji) in z dvema ponovitvama. Vhodne spremenljivke (faktorji) so bili osnovni parametri pri čelnem rezkanju: hitrost vrtenja vretena (pet nivojev: 2000, 3500, 5000, 6500 in 8000 rpm), podajanje na zob (šest nivojev: 0.025, 0.1, 0.175, 0.25, 0.325, 0.4 mm/zob) in globina reza (dva nivoja: 1 in 2 mm). Izhodna spremenljivka (odziv) je bila aritmetično povprečje profila hrapavosti *Ra.* Za vsak vzorec je bila dobljena digitalna slika obdelane površine. Na osnovi načrtovanja eksperimentov in dobljenih rezultatov je bila narejena baza vhodnih podatkov (značilnosti) pridobljenih iz digitalnih slik obdelanih površin. Ta baza je bila nato uporabljena za obdelavo z adaptivnim nevro-mehkim inferenčnim sistemov (ANFIS). Ocenjena napaka, tj. primerjava med vrednostjo *Ra*, pridobljeno s pomočjo sistema ANFIS z resnično vrednostjo *Ra,* je bila izražena z normalizirano srednjo kvadratno napako (NRMSE), ki je znašala 0.0698 oziroma 6.98 %.

PODATKI O ČLANKU

Ključne besede:
Površinska hrapavost
Čelno rezkanje
Digitalna slika
Adaptivni nevro-mehki inferenčni sistem

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