

Investigation of dynamic elastic deformation of parts processed by fused deposition modeling additive manufacturing

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ABSTRACT

Fused deposition modeling (FDM) has been recognized as an effective technology to manufacture 3D dimensional parts directly from a digital computer aided design (CAD) model in a layer-by-layer style. Although it has become a significantly important manufacturing process, but it is still not well accepted additive manufacturing technology for load-carrying parts under dynamic and cyclic conditions due to many processing parameters affecting the part properties. The purpose of this study is to characterize the FDM manufactured parts by detecting how the individual and interactive FDM process parameters will influence the performance of manufactured products under dynamic and cyclic conditions. Experiments were conducted through fractional factorial design and artificial neural network (ANN). Effect of each parameter on the dynamic modulus of elasticity was investigated using analysis of variance (ANOVA) technique. Furthermore, optimal processing parameters were determined and validated by conducting verification experiment. The results showed that both ANN and fractional factorial models provided good quality predictions, yet the ANN showed the superiority of a properly trained ANN in capturing the nonlinear relationship of the system over fractional factorial for both data fitting and estimation capabilities.

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Raziskava dinamične elastične deformacije delov, narejenih s pomočjo dodajalne izdelovalne tehnologije neprekinjenega ciljnega nalaganja

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POVZETEK

Neprekinjeno ciljno nalaganje (angl. FDM) se je izkazalo kot učinkovita tehnologija pri izdelavi 3D-kosov po načinu gradnje plast za plastjo, neposredno iz digitalnih CAD-modelov. Čeprav je FDM postal pomemben izdelovalni postopek, še vedno ni dovolj dobro sprejet ko gre za kose, ki so podvrženi povečani obremenitvi, še posebej pa dinamičnim in cikličnim obremenitvam, saj številni procesni parametri pri izdelavi kosov bistveno vplivajo na njihove lastnosti. Namen pričujoče raziskave je raziskati kako vpliva posamezni procesni parameter – prav tako pa soodvisnost več parametrov – na lastnosti kosov pod dinamičnimi in cikličnimi obremenitvami. Eksperiment smo izvedli s pomočjo delnega faktorkega načrta in umetnih nevronske mreže (angl. ANN). Vpliv vsakega parametra na dinamični modul elastičnosti smo raziskali s pomočjo analize variance. Poleg tega smo določili optimalne procesne parametre in jih potrdili z izvedbo testov za verifikacijo. Rezultati so pokazali, da obe metodi, tako ANN kot tudi delni faktorski načrt, omogočata dobro kakovost napovedovanja, vendar pa smo ugotovili, da metoda ANN uspešneje opiše nelinearne relacije v preučevanem sistemu kot pa delni faktorski načrt.

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PODATKI O ČLANKU

Ključne besede:

Dodajalni izdelovalni postopek
Neprekinjeno ciljno nalaganje (FDM)
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Umetne nevronske mreže (ANN)
Procesni parametri
Analiza variance (ANOVA)

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