Tool selection for rough and finish CNC milling operations based on tool-path generation and machining optimisation

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A B S T R A C T

Most of CAD/CAM systems lack fully-automated process planning capabilities and depend on semi-automatic capabilities that necessitate the traditional selection of tools and cutting parameters. This paper attempts to determine proper combinations of cutting tools through the generation of tool paths and optimisation of machining parameters using an example of the CNC milling process. Several machining simulations with different combinations of tool sizes were performed using MasterCAM software. Based on these simulations, substantial variations in tool paths were observed for different tool combinations and as such the optimum tool combination could only be obtained arbitrarily. The tool paths derived from machining simulations were used to optimise machining parameters, that is, cutting speed, feed rate and depth of cut with the objective of minimising production time. In this case, an optimisation model was developed as a nonlinear programming problem and solved using extended LINGO nonlinear software. The results show that the subjectivity when selecting cutting tools can be avoided when appropriate tools are chosen alongside with the generation of a tool path within a CAD/CAM system using optimised machining parameters. As a consequence, CNC machine tools could be effectively utilised and the productivity significantly improved at shorter production time and cost.

Izbira orodij za grobe in fine CNC-obdelave pri rezkanju na osnovi generiranja poti orodij in optimizacije obdelave

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POVZETEK

Velika večina CAD/CAM sistemov nima vgrajene možnosti avtomatskega načrtovanja procesa obdelave, zato se mora uporabnik še vedno posluževati tradicionalne izbire orodij in parametrov odrezovanja. Prispevek opisuje izbiro pravilnih kombinacij obdelovalnih orodij skozi generacijo poti orodij in optimizacijo obdelovalnih parametrov na zgledu CNC-rezkanja. S pomočjo orodja MasterCAM je bilo izvedenih več simulacij obdelave z različnimi orodji. Na osnovi simulacij je bilo ugotovljeno, da se poti orodij za različna orodja bistveno razlikujejo, zato je izbira optimalne kombinacije orodij prepuščena subjektivnemu odločanju. Poti orodij, ki so bile dobljene s pomočjo simulacij, smo nato uporabili za optimizacijo obdelovalnih parametrov, tj. obdelovalne hitrosti, podajanja in globine reza, pri čemer je bil cilj minimizirati čas izdelave. Takšna postavitev problema ima nelinearen značaj, zato smo ga rešili z razširjeno LINGO programsko opremo, ki omogoča reševanje nelinearnih problemov. Rezultati so pokazali, da se lahko subjektivnosti pri izbiri rezalnih orodij izognemo, če poleg ustrezne izbire orodij generiramo tudi poti orodij znotraj CAD/CAM sistema s pomočjo optimalnih parametrov odrezovanja. Predlagan pristop omogoča, da so CNC-stroji učinkoviteje izrabljeni ob hkratni povečani produktivnost, kar vodi k skrajšanju izdelovalnega časa in stroškov.

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