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Determination of accuracy contour and optimization of workpiece positioning for robot milling

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ABSTRACT

Workpiece positioning into a machine's workspace has become a simple task. Advanced CNC machines are equipped with standardized clamping systems, allowed workpiece dimensions are listed in the machine's documentation and tolerance levels of the end produced parts are known. This gives users plenty of information and good confidence that they are choosing the best machine for a specific task. For more universal machines like industrial robots this is not the case. Due to their flexibility industrial robots can be an alternative to specialized CNC machines, but when a specific task should be executed, important information is missing. For a standard industrial robot the mechanisms layout, its dimensions and its reachable workspace is known, but accuracy levels over the robot's workspace are not. If a workpiece should be milled within certain accuracy limits the robot's documentation offers no information on how close it can be located to the borders of the robot's workspace. This article deals with the mentioned problem with a novel methodology. Based on experimental data we found that a standard 6 DOF industrial robot's reachable workspace can be divided into two regions, one with suitable milling accuracy and another with rapidly decreasing milling accuracy. To isolate the suitable accuracy region a regional non-dominated sorting algorithm was developed and an accuracy contour separating the regions was extracted. In the second part of the article a genetic search algorithm based on regional non-dominated sorting was applied to find the biggest arbitrary shaped workpiece's size, position and orientation in the suitable milling accuracy region of the robot's workspace.

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Izvirni znanstveni članek

Določitev meje natančnosti in optimizacija postavitve obdelovanca pri robotskem rezkanju

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POVZETEK

Postavitev obdelovanca v delovni prostor obdelovalnega stroja je dandanes preprosta naloga. Sodobni CNC stroji so opremljeni s standardiziranimi vpenjalnimi napravami, dovoljene mere obdelovanca so predpisane v dokumentaciji stroja, tolerančne mere končnega izdelka pa so znane vnaprej. Uporabnik tako brez težav izbere najboljši stroj za določeno nalogo. Za bolj splošne naprave kot so industrijski roboti pa to ne velja. Zaradi svoje prilagodljivosti so industrijski roboti lahko alternativa specializiranim CNC strojem, a ko je potrebno izvesti določeno nalogo, pomembni podatki manjkajo. Za standardne industrijske robote proizvajalec podaja topologijo, mere in dosegljiv delovni prostor, natančnosti po celotnem delovnem prostoru pa ne. Če želimo rezkati izdelek z določeno natančnostjo, v dokumentaciji ne najdemo podatka kako blizu mej delovnega prostora robota se obdelovanec še lahko nahaja. Ta prispevek predlaga novo metodologijo za rešitev omenjenega problema. Na podlagi eksperimentalnih podatkov je bilo ugotovljeno, da lahko delovni prostor industrijskega robota s šestimi prostostnimi stopnjami razdelimo na dve področji, eno s primerno natančnostjo rezkanja in eno s hitro padajočo natančnostjo rezkanja. Za osamitev področja primernega za rezkanje smo razvili algoritem za področno nedominirano razvrščanje in pridobili mejo natančnosti, ki ločuje omenjeni področji. V drugi polovici prispevka smo uporabili genetski algoritem, zasnovan na nedominiranem razvrščanju in našli največji obdelovanec poljubne oblike ter njegovo pozicijo in orientacijo v področju primernem za rezkanje znotraj celotnega delovnega prostora robota.

PODATKI O ČLANKU

Ključne besede:
Robotsko rezkanje
Meja natančnosti
Postavitev obdelovanca
Nedominirano razvrščanje
Genetski algoritem
Optimizacija

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