

Closed-loop simulation of workload control: Integrating input-output regulation with feedback

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ABSTRACT

When responsiveness to demand fluctuations is a key performance factor, continuous dynamic models can advantageously replace discrete event simulation, often employed in Workload Control (WLC) studies. Nonetheless, dynamic modelling tools and feedback control are scarcely applied to WLC or other shop floor control systems. To fill this gap, this paper presents a closed-loop model of WLC incorporating feedback control and shop floor input-output control. The bond graphs' dynamic modelling technique is employed. The model is implemented in Simulink® and its behaviour in face of disturbances is analysed. The load of the machines and of the job pool of WLC is considered to adjust order release (input control). The capacity of each machine (output control) is altered in function of the level of its preceding buffer. The machines' processing rates stabilize and the reference levels for the buffers are reached when a step disturbance in order entry is simulated. Also, the system responded with a maximum capacity increment of 15 % when cyclic demand is simulated. This novel approach of a smart production control system can help managers to better control shop floor load in response to disturbances.

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Simulacija nadzora delovne obremenitve v zaprti zanki: integracija vhodno-izhodnega vodenja s povratno zanko

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POVZETEK

Ko je sposobnost hitrega odzivanja na nihanja povpraševanja ključnega pomena za uspešnost proizvodnega sistema, lahko zvezni dinamični modeli učinkovito nadomestijo simulacijo diskretnih dogodkov, ki se pogosto uporablja v raziskavah nadzora delovne obremenitve (Workload Control – WLC). Kljub temu se orodja za dinamično modeliranje in vodenje s povratno zanko redko uporabljajo pri WLC ali drugih sistemih nadzora proizvodnje. V ta namen je predstavljen model nadzora delovne obremenitve v zaprti zanki, ki vključuje vodenje s povratno zanko in vhodno-izhodno vodenje proizvodnje. Uporabljena je tehnika dinamičnega modeliranja z veznimi grafi (angl. bond graphs), model pa je implementiran v okolju Simulink®, kjer je analizirano njegovo obnašanje ob motnjah. V sistemu WLC se sproščanje naročil (vhodno vodenje) določa glede na obremenitev strojev in stanje naročil, zmogljivost posameznega stroja (izhodno vodenje) pa se prilagaja glede na količino izdelkov v vstopnem zalogovniku. Pri stopničasti spremembi števila prejetih naročil se obdelovalne zmogljivosti strojev postopoma stabilizirajo, zalogovniki pa dosežejo svoje ciljne ravni. Sistem se je pri periodičnih spremembah povpraševanja odzval z največjim povečanjem zmogljivosti za 15 %. Predlagani pristop predstavlja nov koncept pametnega nadzora proizvodnje, ki lahko vodjem omogoči učinkovitejše obvladovanje obremenitev proizvodnih kapacitet ob pojavih motenj.

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Nadzor delovne obremenitve;
Sistemi v zaprti zanki;
Simulacija;
Pametni proizvodni sistemi;
Teorija vodenja;
Vezni grafi (bond graphs);
Vhodno-izhodno vodenje;
Proizvodnja

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