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Dynamic scheduling for manufacturing workshops using Digital Twins, Competitive Particle Swarm Optimization, and Siamese Neural Networks

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ABSTRACT

Flexible manufacturing workshops often encounter scheduling challenges due to complex processes and cumbersome procedures. To address these issues, a dynamic scheduling method is proposed. Initially, a discrete manufacturing workshop scheduling problem model is developed, considering the unique characteristics of the workshop. Digital Twin technology and a Competitive Particle Swarm Optimization algorithm are then integrated to create the scheduling model. Finally, Siamese Neural Networks are incorporated to form a dynamic scheduling mechanism that optimizes disturbance scheduling. The research model demonstrated a quick convergence, efficiently searching for the optimal fitness value using both the Sphere and Griewank functions. In the scheduling objective function test, the model achieved a maximum completion time of 244.8 minutes, the shortest time compared to similar technologies. In Siamese Neural Network experiments, the model successfully suppressed the influence of disturbances, maintaining optimal scheduling performance. Without adjustments for disturbances, the maximum completion time was 58.5 minutes. After optimization, it decreased to 54.2 minutes. These results demonstrate the effective application of the proposed technology in workshop scheduling. The findings provide valuable technical insights for the application of intelligent technologies in workshop scheduling optimization.

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Izvirni znanstveni članek

Dinamično terminiranje za proizvodne delavnice z uporabo digitalnih dvojčkov, tekmovalna optimizacija z rojem delcev, in siamskih nevronskih omrežij

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P O V Z E T E K

Prilagodljive proizvodne delavnice se zaradi zapletenih procesov in okornih postopkov pogosto srečujejo z izzivi pri terminiranju. Za reševanje teh težav je predlagana dinamična metoda terminiranja. Na začetku je razvit model problema terminiranja v diskretni proizvodni delavnici, pri čemer so upoštevane edinstvene značilnosti delavnice. Nato sta za oblikovanje modela terminiranja vključena tehnologija digitalnega dvojčka in algoritem tekmovalnega optimiziranja s pomočjo roja delcev. Nazadnje so vključene siamske nevronske mreže za oblikovanje dinamičnega mehanizma za terminiranje, ki optimizira terminiranje z motnjami. Raziskovalni model je izkazal hitro stekanje in je učinkovito poiskal optimalno vrednost fitnesa z uporabo funkcij Sphere in Griewank. Pri preizkusu ciljne funkcije za problem terminiranja je model dosegel najdaljši čas izvedbe 244,8 minute, kar je najkrajši čas v primerjavi s podobnimi tehnologijami. Pri poskusih s siamsko nevronsko mrežo je model uspešno odpravil vpliv motenj in ohranil optimalno učinkovitost terminiranja. Brez prilagoditev za motnje je bil najdaljši čas dokončanja 58,5 minute. Po optimizaciji se je skrajšal na 54,2 minute. Ti rezultati kažejo na učinkovito uporabo predlagane tehnologije pri terminiranju delavnic. Rezultati zagotavljajo dragocena tehnična spoznanja o uporabi inteligentnih tehnologij pri optimizaciji terminiranja v delavnicah.

P O D A T K I O Č L A N K U

Ključne besede:
Proizvodna delavnica;
Terminiranje;
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Tekmovalni roj delcev
Optimizacija;
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