Productivity improvement with parallel adjacent U-shaped assembly lines

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ABSTRACT

A novel configuration of assembly lines was proposed in this research, namely parallel adjacent U-shaped assembly lines (PAUL). Typically, in a multiple U-line facility, each U-line is designed to work independently which may cause some workstations were not fully functioned. The PAUL aimed at increasing the utilisation of the whole facility by allowing cross-trained workers to work on the opposite legs of the adjacent U-lines (multi-line workstations). This configuration is easier to implement than parallel U-lines due to no restriction in terms of the lengths of U-lines to be paralleled and hidden expenditures that could be incurred in shop floor reconstruction. Since the line balancing of the PAUL is NP-hard and many conflicting objectives need to be optimised simultaneously, the evolutionary meta-heuristic which was the hybridisation of the multi-objective evolutionary algorithm based on decomposition (MOEA/D) and particle swarm optimisation (PSO), namely MOEA/D-PSO, was developed to effectively solve the problem. In addition, the decoding algorithm to convert the solutions obtained from MOEA/D-PSO into the PAUL's configuration was proposed. The performance of MOEA/D-PSO was evaluated against MOEA/D and multi-objective particle swarm optimisation (MOPSO). The experimental results reveal that MOEA/D-PSO outperformed its rival algorithms under the convergence-related performance.

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Izboljšanje produktivnosti z vzporednimi sosednjimi montažnimi linijami v obliki črke U

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POVZETEK

V tej raziskavi je bila predlagana nova konfiguracija montažnih linij, in sicer vzporednih sosednjih montažnih linij v obliki črke U (PAUL). Običajno je v objektih s postavitvijo več U-linij vsaka U-linija zasnovana tako, da deluje neodvisno, kar lahko povzroči, da nekatere delovne postaje niso bile popolnoma delujoče. Cilj konfiguracije PAUL je bil povečati izkoristek celotnega objekta, tako da je usposobljenim delavcem omogočil delo na nasprotnih krakih sosednjih U-linij (več linijske delovne postaje). To konfiguracijo je lažje izvesti kot vzporedne U-linije, ker ni omejitev glede dolžine vzporednih U-linij in skritih stroškov, ki bi lahko nastali pri preoblikovanju proizvodne hale. Ker je uravnoteženje linij PAUL računsko zahtevno in je treba hkrati optimizirati številne nasprotujoče si kriterije, je bil razvit evolucijski metahevristični algoritem MOEA/D-PSO, ki je hibridizacija večkriterijskega evolucijskega algoritma, ki temelji na razgradnji (MOEA/D) in optimizaciji z rojem delcev (PSO). Poleg tega je bil predlagan algoritem za pretvorbo rešitev, pridobljenih iz MOEA/D-PSO, v konfiguracijo PAUL. Učinkovitost MOEA/D-PSO je bila ovrednotena glede na MOEA/D in glede na večkriterijsko optimizacijo z rojem delcev (MOPSO). Eksperimentalni rezultati razkrivajo, da je MOEA/D-PSO v konvergenčni uspešnosti presegel konkurenčne algoritme.