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Balance Study of Clothing Single-piece Production Line Based on Dual-population Genetic Algorithm ⋆

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Abstract

Currently, line production is the mainstream production method for various clothing enterprises. Therefore, optimising and improving the production line plays a crucial role in promoting the development of manufacturing enterprises. To solve the problems of unbalanced operation time and low production line balance rate of each workstation of the garment sewing production line, a multi-objective optimisation mathematical model with the minimum smoothing index and the largest production line balance rate was established, and the dual-population genetic algorithm was designed in the MATLAB environment. The jeans (front piece) were used as an example to be simulated and verified in simulation software. Achieve load balancing at workstations, save production costs, and eliminate overproduction between jobs. The research results show that the smoothness index of the optimised production line has been reduced from 20.89 to 8.43, and the production line balance rate has been increased from 77.57% to 89.06%, which meets the requirements of enterprise process planning and can deliver on time. This verifies that the model proposed in this paper can effectively solve the production balance problem of a single clothing production line.

Keywords: Dual-population genetic algorithm; Balance optimisation; Garment sewing line; Simfactory software

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1 Introduction

In the fierce market competition environment, garment enterprises need to continuously reduce costs, shorten production cycles and improve production efficiency while ensuring quality to improve market competitiveness. One of the most important aspects is the issue of line balancing, which can lead to chaos in the production line cycle time. For a long time, the design and balance control of the production line in the garment production process have largely relied on the personal experience of the production technicians. However, the results of line orchestration using this empirical knowledge are often suboptimal, and it is difficult to ensure that each workstation can achieve the same production speed to achieve a true balance. There are often multiple optimisation goals in garment production. Staffing results based on the personal experience of production technicians often make it difficult to meet the actual needs of production. The development of intelligent algorithms can effectively solve this problem, but at present, the research on the balance of production lines is mainly concentrated in the manufacturing fields, such as machinery and electronics, and there are few studies on the balance of clothing sewing production lines. As a good approximation algorithm for global search, the two-population genetic algorithm has been successfully applied to solve the production line balance problem, and the approximate optimal solution can be reached faster.

Some scholars have used genetic algorithm [1, 2] and ant colony algorithm [3] to optimise the balance of the production line, which have been verified in Flexsim; Song Y [4-6] used Flexsim software to simulate the single-piece assembly line of T-shirts and silk cheongsams, and greatly improved the balance rate of the assembly line through the optimal combination of processes; Sun Y [7-8] established a simulation model of women's cotton clothing assembly line that is in good agreement with actual production. The simulation model of men's jacket assembly line was established and optimized, and the optimization of assembly line preparation efficiency and production efficiency were improved; Zhang Q [9] combined with the specific situation of bra sewing line management, applied genetic algorithm to optimize the process arrangement and equipment position, established the corresponding optimization model, and used MATLAB to implement it, and used virtual sewing line simulation software to test the feasibility and optimization effect of the established optimization model; Chen JC [10] proposed a grouping genetic algorithm for sewing threads of different labor skill levels in the garment industry, and evaluated the performance of the grouping genetic algorithm through the actual data and experimental design of garment factories; Bongomin O [11] using the method of position weight, taking a type of women's pants as the research object, by establishing two kinds of production lines with and without equipment constraints, the production balance rate was verified and concluded that the position weight method was more suitable for the assembly line setting with a small number of equipment and the same, and the application of virtual simulation technology to improve the production balance rate of the assembly line was put forward; Samattapapong N [12] used Flexsim virtual simulation technology to optimise the virtual simulation of a warehouse logistics production line, identified the bottlenecks of the production line after the simulation run, and verified the feasibility of Flexsim virtual simulation software in improving the efficiency of the production line through round-robin testing. Feasibility: Fattahi P and Zaman T [13, 14] performed equilibrium optimisation of the assembly line through intelligent algorithms; El-hawary IA [15] simulated the production line to produce multiple models simultaneously to find the maximum number of products that could be manufactured in the product mix with high quality and without wasting time; Xu YN [16] used the established model to simulate the T-shirt production line, explored the