A Multi-Objective Particle Swarm for a Mixed-Model Assembly Line Sequencing

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Summary. Mixed-model assembly line sequencing is one of the most important strategic problems in the field of production management. In this paper, three goals are considered for minimization; That is, total utility work, total production rate variation, and total setup cost. A hybrid multi-objective algorithm based on Particle Swarm Optimization (PSO) and Tabu Search (TS) is devised to solve the problem. The algorithm is then compared with three prominent multi-objective Genetic Algorithms and the results show the superiority of the proposed algorithm.

1 Introduction

A mixed-model assembly line is a type of production line capable of producing several small-sized production lots.

The structure of this paper is as follows. In section 2 considered problem is described. The Proposed algorithm will be treated in section 3. Experimental results will be given in section 4 and finally, the paper will be concluded in section 5.

2 Multi-Objective Sequencing Problem in MMAL

A MMAL considered in this paper is a conveyor system moving at a constant speed (v_c).The line is partitioned into J stations. It is assumed that the stations are all closed types. The worker moves downstream on the conveyor while performing his/her tasks to assemble a product. The design of the MMAL involves several issues such as determining operator schedules, product mix, and launch intervals. Early-start operator schedule is used in this paper (Hyun, et. al. [2]).In addition, the minimum part set (MPS) production, which is widely accepted in mixed model assembly lines, is also used in this paper. MPS is a vector representing a product mix, such that (Q_1, Q_2,...,Q_M); where M is the total number of models. This strategy operates in a cyclical manner. The number of products produced in one cycle is given by ($I = \sum_{i=1}^{M} Q_i$) . The capacity of this line is limited with the maximum value, (C_{max}) , so that ($C_{max} \leq I$) . Third, the launch interval (γ) is set to ($\frac{T}{I \times J}$), in which T is the total operation time required to produce one cycle of MPS products.

The first objective considered is the minimization of the total utility work. The utility work is typically handled by the use of utility workers assisting the regular workers during the work overload.This objective is taken from Hyun, et al. [2]. The second objective is the minimization of the total production rate variation. One basic requirement of JIT systems is the continual and stable part supply. The objective can be achieved by matching demand with actual production. This objective is taken from Miltenberg [6]. The final objective is the minimization of the total setup cost. In a mixed Model Assembly Line, sequence-dependent setup costs constitute a considerable part of the total cost incurred to the system. Hence minimizing this cost will be highly beneficial for the system. This objective is taken from Hyun, et. al. [2].

3 The Proposed Multi-Objective Particle Swarm

Particle swarm was originated in 1995 by Kennedy and Eberhart [3] after studying the social behavior of birds.

3.1 Solution Representation

In addition to the typical job-to-position representation used in the context of MMAL problems, a real encoding is also used when applying the PSO. However, the real encoding does not represent a solution. To find the standard permutation of product models from real encoding, as many as the number of the first product models will be scheduled in the place of as many smallest numbers of the coordinates of the position vector of a particle. the next product models will be scheduled in the place of the next smallest values of the coordinates of the position vector, and so on. The assignment among each product type will be done arbitrarily. To obtain the job-to-position representation from real encoding as required, random numbers are generated and the smallest of them will be assigned to the first product model, the next smallest, to the second product model and so on.

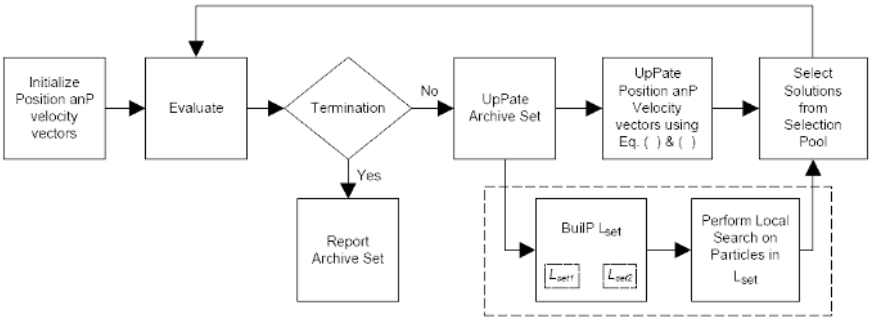

Fig. 1. Proposed Algorithm