Available online at www.sciencedirect.com
ScienceDirect
Computers & Industrial Engineering 53 (2007) 313–320
computers & industrial engineering
www.elsevier.com/locate/dsw

Integration of genetic algorithm and Gantt chart for job shop scheduling in distributed manufacturing systems

H.Z. Jia, J.Y.H. Fuh *, A.Y.C. Nee, Y.F. Zhang

Department of Mechanical Engineering, National University of Singapore, 9 Engineering Drive 1, Singapore 117576, Singapore

Available online 15 June 2007

Abstract

In a distributed manufacturing environment, jobs in a batch could usually be manufactured in several available factories and thus have multiple alternative process plans. This paper presents a new approach to determine good combinations of factories (process plans) to manufacture the jobs and in the meantime generate good operation schedules. A genetic algorithm (GA), integrated with Gantt chart (GC), is proposed to derive the factory combination and schedule. The integration of GA–GC is proved to be efficient in solving small-sized or medium-sized scheduling problems for a distributed manufacturing system. Multiple objectives can be achieved, including minimizing makespan, job tardiness, or manufacturing cost. An illustrative example is given to demonstrate and evaluate the performance of the GA–GC approach.
© 2007 Published by Elsevier Ltd.

Keywords: Genetic algorithm; Gantt chart; Production scheduling

1. Introduction

Traditionally, process planning focuses on the selection of the machines and set-up of machine parameters for job operations, while production scheduling deals with the assignments of machines as well as manufacturing times to process the job operations. With the prevailing trends of globalized manufacturing in recent years, the production of a part would have several feasible process plans, each for a different geographically distributed factory. Accordingly, job scheduling in such a distributed manufacturing system becomes more difficult than conventional job scheduling.

Determining an efficient schedule for general job shop problems has been the subject of research for several decades. The generation of scheduling plans for job shops has been literarily addressed using optimization approaches (for example, Potts & Wassenhove, 1985; Schrage & Baker, 1978; Yano & Kim, 1991) or approximation approaches (for example, Dauzere-Peres & Paulli, 1997; Mastrolilli & Gambardella, 1998; Verma & Dessouky, 2000). Among the various solution approaches to different scheduling problems, there has been an increasing interest in applying genetic algorithms (GAs) to solve the engineering optimization including

* Corresponding author. Fax: +65 6779 1459.
E-mail address: mpefuhyh@nus.edu.sg (J.Y.H. Fuh).

0360-8352/$ - see front matter © 2007 Published by Elsevier Ltd.
doi:10.1016/j.cie.2007.06.024

manufacturing scheduling (for example, Fang, Ross, & Corne, 1993; Hou, Ansari, & Ren, 1994; Zalzala & Fleming, 1997; Park, Choi, & Kim, 2003; Srikanth & Barkha, 2004). Frequently, genetic algorithms are able to outperform many optimization or approximation approaches.

When dealing with the scheduling problem in a distributed manufacturing system, in which one job could be manufactured in several available factories, and thus have multiple alternative process plans, the commonly used genetic algorithms appear not flexible enough to choose a good factory (process plan) combination and in the meantime give good job processing schedule. Considering the above aspects, this paper addresses an innovative GA, which applies crossover operator once and mutation operator twice to simultaneously improve the factory selections and job sequence selections. When integrated with Gantt chart (GC), the proposed genetic algorithm could generate good scheduling results with different objectives including makespan minimization, cost minimization, etc. in a reasonable computational time. Jia, Nee, Fuh, and Zhang (2003) proposed a modified GA to solve the job shop scheduling problems in a distributed manufacturing environment. The GA developed in this paper is an extension of the pervious work and it uses the integration of the GA with the GC in order to solve the small-sized or medium-sized scheduling problems in an more efficient and effective manner. The rest of the paper is organized as follows. In Section 2, we introduce the characteristics of a general distributed manufacturing system. In Section 3, the proposed GA is described in detail. Moreover, the integration of the GA and the GC is presented. Section 4 gives an illustrative example to demonstrate the use of the proposed GA in solving the scheduling problems for distributed manufacturing systems. Finally, we give conclusions in Section 5.

2. Description of the distributed manufacturing system

In a distributed manufacturing system, multiple factories can be selected to manufacture the jobs. Each factory that is available to process the jobs may have different machines and machine available times. In addition, each job involves many processing operations based on the features of the part and has different process plans, each suited for an available factory. To generate the manufacturing schedule in such a distributed manufacturing environment, two problems need to be considered:

- The selection of the factory (process plan) for each job; and
- The assignments of the machines and the times to process the operations of each job.

To address these two problems, we use the following notations to represent the elements in the distributed manufacturing system including the jobs, machines, and factories.

J_i = the ith job in the job batch;
J_iO_j = the jth operation of job i;
F_k = the kth factory that is available to process the jobs;
F_kM_q = the qth machine in factory k;
$PP - J_iF_k$ = the process plan of factory k in processing job i.

With these notations, the relationship among the jobs, machines, and factories in a distributed manufacturing system can be depicted as follows in Fig. 1.

3. Proposed genetic algorithm

3.1. Representation of selected factories and job operations

In a distributed manufacturing environment, where jobs will be dispatched to many factories, the encoding of the scheduling problem becomes more complex since the chromosomes have to comprise more information including the selected factory for every job as well as the job's operation sequence. One advantage of the GA is that it treats the factors of a problem as genes, and then arranges the genes in all possible ways to obtain the

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
✓ امکان دانلود نسخه ترجمه شده مقالات
✓ پذیرش سفارش ترجمه تخصصی
✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
✓ دانلود فوری مقاله پس از پرداخت آنلاین
✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات