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A Study of Research Issues in Dynamic Job Shop Scheduling

Savita Kumari Sheoran
Associate Professor & Chairperson
Department of Computer Science & Applications
Chaudhary Ranbir Singh University, Jind (Haryana) – INDIA

Kirty
M.Phil. (CS) Research Scholar
Department of Computer Science & Applications
Chaudhary Ranbir Singh University, Jind (Haryana) India

Abstract: Job shop Scheduling is classical combinational optimization technique generally used in manufacturing environment. The state of art of available for this technique was limited to static approach with single machine production shop only. But most the real world is dynamic where changes happen unexpectedly, which require dynamic job shop scheduling. One of the specific feature of dynamic job shop scheduling (DJSSS) is most of the problems are NP-hard and hence depends on approximation to optimize in computational times. This research paper will study the dynamic job shop scheduling for available scope research in this area. A specific research problem of immediate interested is formulated and objectives are set forth to solve it. Such solution will pave a way for experimental implementation of job shop scheduling technique in multi machine dynamic job shop.

Keywords: Job shop scheduling, dynamic scheduling, ant colony optimization, task optimization.

1. INTRODUCTION

A job is characterized by its route, processing time and priority. In shop scheduling main issue is to decide how and when to schedule. Job Shop Scheduling (JSP) aim to determine the sequence in which jobs will be process at each machine i.e. object of optimization the process. Scheduling can be defined as the process of assigning of a set of tasks to the resource over time. Job shop scheduling problem is one of the most popular scheduling. A job shop scheduling problem come under classical combinational problem and is very difficult solved by conventional optimization technique. Scheduling in job shop environment with occurring of uncertain and real time events is called dynamic job shop scheduling. This paper analyzes the limitation of static approach when rescheduling in dynamic environment. When a new job arrival in scheduling process then a new schedule is regenerated. This problem can be solved using non-traditional optimization technique like ant colony optimization.

A Job shop scheduling is a classical combination optimization problem. In a job shop a finite number of jobs are to be processed by a finite number of machines. Each job contain a sequence of operation which will be processed on a predefine machine without interruption [1]. The operation of each job should be processed by one by one in given order without preemption and at most one operation processed at each machine one time. Maximum time of completion of all jobs is called makespan.

Main objective of job shop scheduling is minimized the makespan i.e. time length of the schedule in which all operation of each job is completed. There are some real time problems which arise during the process of production e.g. machine breakdown, new job arrive. Such type of problem solved dynamically [2]. Job shop scheduling problem involves following constraints:

- There can be 'n' independent jobs to accomplish on 'm' machines.
- A specific operation of job can be performed by only one predefined type of machine.
- An operation of a job can't be processed until its preceding operation is completed.
- Each machine can process one job or specific number of jobs at a time.
- Each job must go through predefine sequence rule.
- For each operation, there is a set of machines capable to perform it.

The real world environment of manufacturing sector is dynamic where disruptions arrive unexpectedly. In such environment following two types of disruptions are generally encountered:

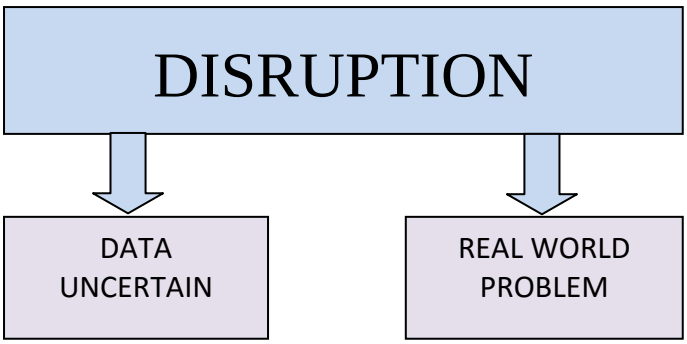

Fig1: Types of Disruptions in Dynamic Environment

Data uncertain: The information may be uncertain and change over time e.g. due date of a job may change dynamically since less important today may be more important tomorrow. Change in job priority or batch size also belong to information are uncertain.

Real time important: There are two type of real event occur. In the first way the non operation disruption assumption occur in job shop scheduling e.g. one machine break-down

suddenly. In second way dynamic events occur unpredictably e.g. new job arrive. The subsequent section will recapitulate the available literature in this area.

2. LITERATURE REVIEW

There are lot of research is done by researcher on job shop scheduling using many evolutionary algorithm like genetic algorithm, ant colony optimization, particle swarm optimization etc. Dynamic dispatching rule was most used scheduling algorithm for due date related job shop scheduling. In 2003, Lengyel et al [3] used Feasibility Function (FF) to schedule jobs in multi machine random shop where purposed to minimize inventory or tardiness costs. Reducing the difference between the maximum and the minimum lateness of jobs It had been observed that no single rule perform well for all important criteria related to flow time ,job tardiness and other system performance measures. Xia et al (2003) [4] combined the particle swarm optimization (PSO) and simulated annealing (SA). PSO combined the local search (by self experience) and global search (by neighbor experience) for high search efficiency. SA as a local search algorithm for avoid local optimum and effective for sequencing and scheduling. The proposed algorithm was effective approach for multi objective FJSP and large scale applicable.

In 2007, M. Saidi-Mehrabad and P. Fattahi [5] minimized the makespan time to find the best sequence of operations and the best choice of machine alternatives, simultaneously. The proposed tabu search algorithm is composed of two parts: a procedure that searches for the best sequence of job operations, and a procedure that finds the best choice of machine alternative. A mathematical model has been developed to describe the characteristics of these problems. This mathematical model is solved by the branch and bound method on lingo software to attain the optimal solutions. Computational results show that the proposed algorithm generates good quality solutions, comparable to the branch and bound method, very quickly.

L. De Giovanni and F. Pezzella (2010) [6] These rules use a combination of dispatching rules which result in a better improvement than rules using a single job attribute like SPT, EDD, or FIFO. Due to the complexity of the job shop scheduling problem, authors generally use heuristic and meta heuristic algorithms to solve the problem, including ACO algorithms. ACO was inspired by the pheromone trail-laying behavior of ants and their following of this trail. Artificial ants in ACO are stochastic solution construction procedures that build candidate solutions for the problem instance under concern, by exploiting artificial pheromone information that is adapted based on the ant search experience and possibly available heuristic information. ACO was successfully applied to many problems such as the traveling salesman problem and mentioned earlier job shop scheduling.

In 2016, E. Ahmadi et al [7] used multi objective optimization approach for flexible job shop scheduling problem under random machine breakdown by evolutionary algorithm. The efficiency of two algorithms was compared based on the diversity, spacing, MMID, NPS and Time criteria. Statically hypothesis was used to evaluate the algorithm with high performance.

3. RESEARCH GAP

Since there is lot of researches are done on static and dynamic job shop scheduling in single and multiple objective problems. Still there is a gap between what is done and what is required to solve optimization issues in dynamic job shop. Based upon literature study following research gap is noted in this area:-

- Most of researcher currently working either on uncertain data or real time events. As per available literature both parameters are still not implement simultaneously [8].
- In the real time events parallel parameter are still not implement simultaneously i.e. machine breakdown, new job arrival, uncertain processing time, change in job specification etc, generally occure simultaneously, but its synchronized implementation is still a challenge for research community[9].
- The rescheduling in job shop where machine breakdown and at new job arrival is a complex issue and need to be resolved to harness maximum from weird potential available in the field [10].

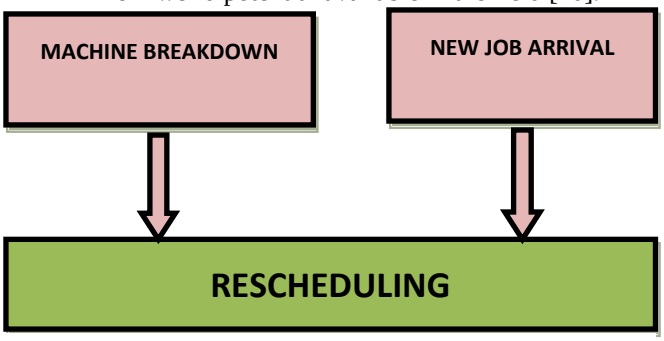

Fig. 2: Research Gap in Dynamic Job Shop Scheduling

4. SPECIFIC RESEARCH PROBLEM

In the light of above discussion there is need to work in direction of job scheduling with multiple parameter. These research problems may be defined as job shop problem with multiple parameter i.e. machine breakdown, new job arrival, processing time uncertain, change in due dates etc. Scheduling approach must improve the flexibility of scheduling operation. With increased flexibility disruption could be handling with less impact on the system. To handle these parameters in job shop scheduling problem there is need to implement some effective rescheduling technique for job execution.

Evolutionary Algorithms (EAs) are best optimization approach when simulate the processing of natural evolution. EAs have been recognised for multiple objective optimization problems to solve a set of solutions simultaneously in one run.

4.1. Research Objective

Keeping in view the problem statement under references research has following objectives:

- Study and analysis of existing research DJSSS with aim to find out best sequence for processing on each machine in an uncertain and dynamic environment using evolutionary algorithm.
- Design and develop a model for DJSSP based on rescheduling approach. Rescheduling approach implement when dynamic event occur.

4.2. Method

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In order to achieve these objectives Ant Colony Optimization algorithm (ACO) technique suit well. ACO is used to search for an optimal path in a graph, based on behavior of ants. In real world ant move randomly and finding food. When one ant find the short path from colony to food source other ants are also follow the shortest path. Shortest path is found using pheromone trails which ants deposited when they travel.

5. CONCLUSION

Since the real world environments is changing dynamically and unprecedented change occure there during the process such as machine breakdown, electricity failure and new job arrival etc. Also the multiple objectives work simultaneously in JSSS. But there is no systematic research available to address these questions of immediate attention. Based upon literature survey we pointed out a specific research gap existing in this field and theoretically formulate a specific research issue along with methodology to solve it. The implementation of theoretical concept presented here through numerical simulation over a suitable computational platform may yield optimal solution to the problem and direct the future direction of research in this area.

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About Authors:

Dr. Savita Kumari Sheoran presently working as Chairperson, Department of Computer Science & Applications and Dean, Faculty of Physical Sciences at CRS University Jind (India), is an academician and researcher of high tempore. She has graduated her Ph.D. from Banasthali University, Rajasthan (India) in 2011 and have about 12 years of teaching and research experience. She has more than 40 national / international papers, 03 books and 01 patent in her credit and has attended about 30 national/international events in India and abroad. She is on the panel of reviewer of various research journals and conferences and has organized national conference in capacity of organizing secretary. She has actively been engaged in research in the area of mobile computing, cloud computing, big data, social networks and learning platforms.

Ms. Kirty presently pursuing towards her M.Phil. in Computer Science at Chaudhary Ranbir Singh University Meerpur, Jind (India) in the area of Dynamic Job Shop Scheduling under supervision of Dr. Savita Kumari Sheoran. She holds Master of Computer Applications from Maharishi Dayanand University, Rohtak. She has research interests in Artificial Intelligence, Machine Learning Algorithms and Optimization Techniques.