An Adaptive Real Time Task Scheduler

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Abstract

Time constraint is the main factor in real time operating system. Different scheduling algorithm is used to schedule the task. The Earliest Deadline First and Ant Colony Optimization is a dynamic scheduling algorithm used in a real time system and it is most beneficial scheduling algorithm for single processor real-time operating systems when the systems are preemptive and under loaded. The main problem in EDF algorithm is that the performance of the system decreases because of overload condition. To solve this problem ACO (Ant Colony Optimization) based scheduling algorithm for real-time operating system is used which assures the overloaded condition. But the ACO algorithm takes more time for completing the task.

The performance of the EDF and ACO is calculated in terms of Success Ratio and Effective CPU Utilization. The goal is to switch automatically between EDF algorithm and ACO based scheduling algorithm to deal overloaded and under loaded conditions.

Keywords: *Real-Time Scheduling algorithm, Earliest Deadline First, Ant Colony Optimization, Fixed Priority until zero laxity, Load balancing.*

1. Introduction

The accuracy of the Real-time system depends on the timelines as well as the effect of computation [1]. A real time system is a system that ensures the exact time requirement for a job. If a real-time system do not complete task in a definite time, it may cause a breakdown of the entire system which is running. Real time system is divided into two types hard real time and soft real time system. In hard real time system deadline is followed all the time but in soft real time system occasionally deadline is missed.

Real time scheduling technique is divided into two types: static and priority driven "fig 1". In static algorithm priorities are assigned at design time. No one can change the priorities because they are fixed. In priority driven approach priorities are assigned at the run time depending upon the deadline of the task [2]. The priority driven approach consists of fixed priority and dynamic priority.

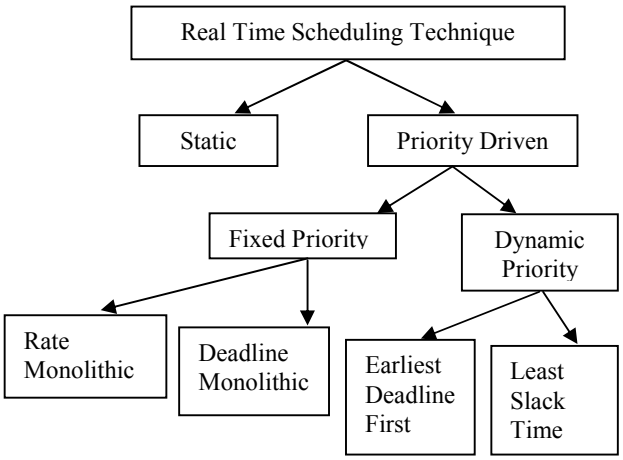

Fig 1: Real Time scheduling technique [1]

1.1 Adaptive Scheduling Algorithm

The behavior of adaptive algorithm depends on the availability of the resources. The adaptive algorithm uses the three algorithms:

a) Earliest Deadline First
b) Ant Colony Optimization
c) Fixed Priority until Zero Laxity algorithm.

EDF is the dynamic scheduling algorithm which places the task in a priority queue [3].Whenever the scheduling event occurs the queue will search for the process closest to its deadline. The priority is assign at the run time depending upon the deadline.

ACO is the branch of swarm intelligence. As the name suggest, ACO algorithm motivated from the performance of natural ants. This algorithm gives good result when the system is overloaded [4].

The fixed priority until zero laxity is a minimally dynamic scheduling algorithm which is based on the state of zero laxity. In zero laxity, the execution time is equal to its deadline [5]. The task which contains a state of zero laxity is given the highest priority. In this

algorithm the priority of a task can change at most once during its run time [6].

The adaptive algorithm will be useful for handling the overloaded and underloaded condition. The algorithm will use the automatic switching between EDF, ACO and FPZL scheduling algorithm. It will be helpful to increase the performance of the system and calculate the Success Ratio, Effective CPU Utilization, Deadline Analysis, CPU Utilization and Response Time.

The whole paper is organized as follow: In section 2, the Literature review is explained and discuss. Section 3 shows the comparative study of the existing algorithm. Section 4 gives complete description of the proposed algorithm. The paper ends with a brief conclusion in Section 5.

2. Review of Existing Technique

Scheduling is the process which assigns the resources to the different task depending on its deadline. Different steps for scheduling are:

1) To check whether a system performs schedualability analysis.

2) If it does then find it is done statistically or dynamically.

3) Whether the result of the analysis itself produces a schedule or plan according to which task are dispatched at run time [7].

2.1 Earliest Deadline First

Earliest Deadline first is the optimal scheduling algorithm for uniprocessor system in the real time system. The limited preemption scheduling technique is beneficial for preemptive and non-preemptive scheduling [8].

Limited-preemption EDF assigns the priorities just as a regular preemptive algorithm, Jobs which contain nearest deadline gives the highest priority and execute it. The working of EDF algorithm is shown in the flowchart "Fig 2".

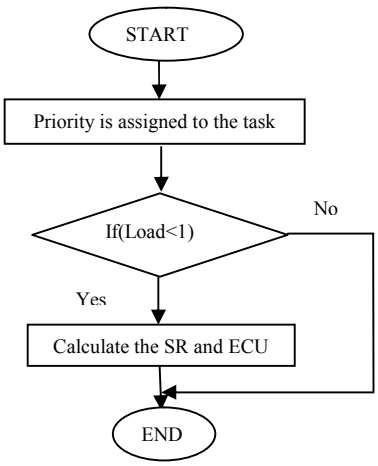

Fig 2: Flowchart of EDF algorithm

The main advantage of EDF algorithm is it utilizes the computing power of CPU and work well when the system is preemptive and underloaded. The limitation of this algorithm is that the performance of the system decreases if the system becomes slightly overloaded.

2.2 Ant Colony Optimization

An ant colony- based scheduling algorithm (ACB-SA) is used to solve the EEC problem. They use the probability sensor detection model which uses a more realistic approach to solve the EEC problem [9].

Ant colony optimization (ACO) algorithm in 1990's [10-12] works on the behavior of ants. Each task is considered as a node and all the ants will start their journey from the different node depending upon the pheromone value and it is updated at every time and the task is selected depending upon the performance [9]. ACO algorithm satisfies the overloaded condition [13]. Pheromone updating on each node is done in two parts:

1. ***Pheromone Evaporation:*** It is necessary to forget bad journey of ants and to support new paths.
2. ***Pheromone Laying:*** Pheromone will be laid only for two best journeys of ants. Select the best journey and put pheromone [14]. The flowchart gives the working of the algorithm "fig 3"

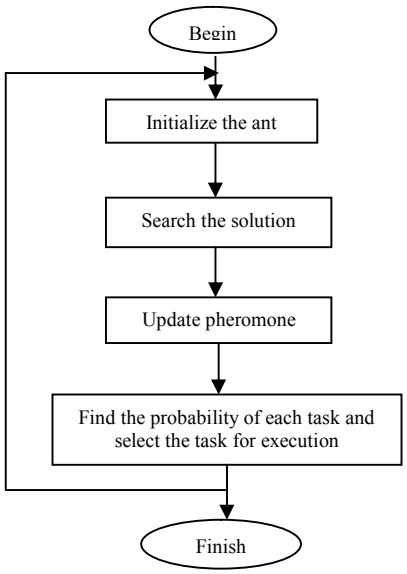

Figure 3: Flowchart of ACO algorithm.

The advantages of ACO algorithm is that it will give the good result when the system is overloaded just opposite of EDF algorithm. This algorithm is well-organized for Traveling Salesman Problem and similar problems. But the limitation of the algorithm is it takes more time for execution as compared to other algorithm. The theoretical analysis is difficult.

2.3 Particle Swarm Optimization Algorithm

PSO [14] is a population based stochastic optimization method, inspired by social behavior of bird flocking or fish schooling [15]. This algorithm consists of the particles called as agent who moves in a search space and find out the best solution [16]. The flowchart gives the complete description of the working of the algorithm "fig 4".

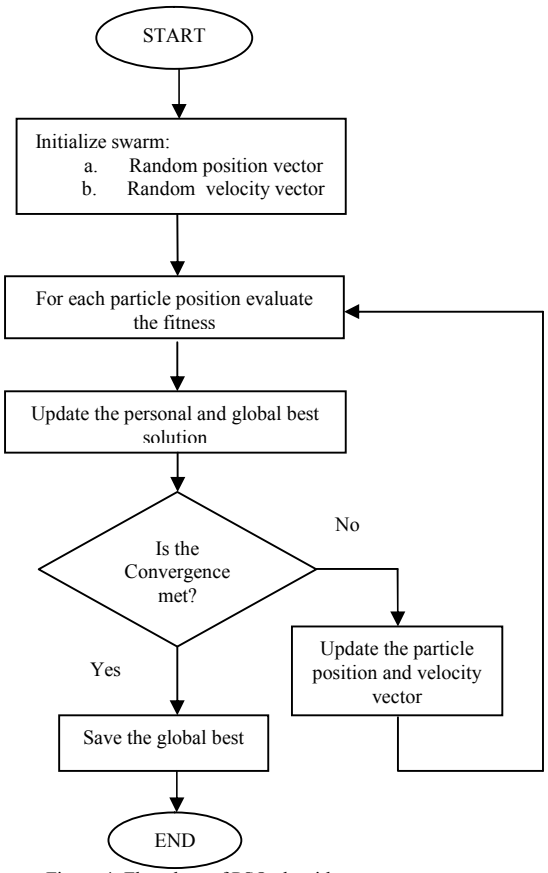

Figure 4: Flowchart of PSO algorithm

The advantages of PSO algorithm is, it is easy to apply and there are a small number of parameters to adjust. PSO has been profitably applied in many areas: function optimization, artificial neural network training, fuzzy system control. PSO have no overlapping and mutation calculation.

The limitation is it cannot solve the problem of scattering and optimization. It cannot solve the problem of non-coordinate system, such as the solution to the energy field and the moving rules of the particles in the energy field.

2.4 Least Slack Time First

It is the scheduling algorithm which assigns the priority based on the slack time. Slack time is the amount of time left after a job if the job was started now. This algorithm is also known as **Least Laxity First**.

Scheduling algorithms based on heuristic functions which are used to dynamically schedule a set of tasks with deadlines and resources requirements [17]. Deadline and the resources are the basic need of the scheduling algorithm in a real time system.

The advantages of LST are to decide which task should execute next at the schedule time and assigning fixed priorities to the tasks at development time. The disadvantage of the algorithm is, it gives the poor runtime behavior.

3. Comparison of Existing Algorithm

Parameter	*EDF[3,8]*	*ACO[4,9,15]*	*FPZL[6,18]*
Load	Underloaded system	Overloaded System	Check the execution time and deadline
Time	Less Time required to execute the task	More Time required to execute the task	Less Time required to execute the task
Speed	Execution speed is good	Less execution speed	Execution speed is good

Table1: Comparison of Existing Scheduling Algorithm.

4. Proposed Algorithm

The scheduling algorithm required when the new task arrive or the running task completes. The proposed algorithm improves the load balancing technique by using the combination EDF, ACO and FPZL scheduling algorithm. To the best of our knowledge, there is no algorithm for switching from EDF to ACO. The adaptive algorithm is used to calculate the SR and ECU where as the FPZL algorithm calculates the CPU Utilization, Response Time and Deadline Analysis. The main steps of the proposed algorithm are as following and the flowchart of the algorithm is shown in "fig 5".

4.1 Step of the proposed algorithm

1. Give priority to each task depending on its deadline and run that task on the system by the user.
2. At the time of executing the application or task, the periodic task is executed by the EDF algorithm.
3. If the task missed the deadline then consider it as an overloaded and then check the condition weather the execution time is equal to the deadline.

4. If the execution time is equal to the deadline then the algorithm switches to the FPZL scheduling algorithm.
5. After executing the FPZL algorithm it will again switch to the EDF algorithm.
6. If the execution time is not equal to the deadline then the algorithm switches to the ACO algorithm.
7. In ACO after more than one job continuously achieve the deadline the algorithm is considered as a overloaded condition disappear and switch to EDF algorithm “Fig 5”.
8. Performance is measured in terms of the Success Ratio, Effective CPU utilization, CPU Utilization, Response Time and Deadline Analysis.
9. Finally the result is calculated in terms of graph and tables.

4.2 Algorithm Flow Chart:

The algorithm EDF-ACO flow chart is as follows:

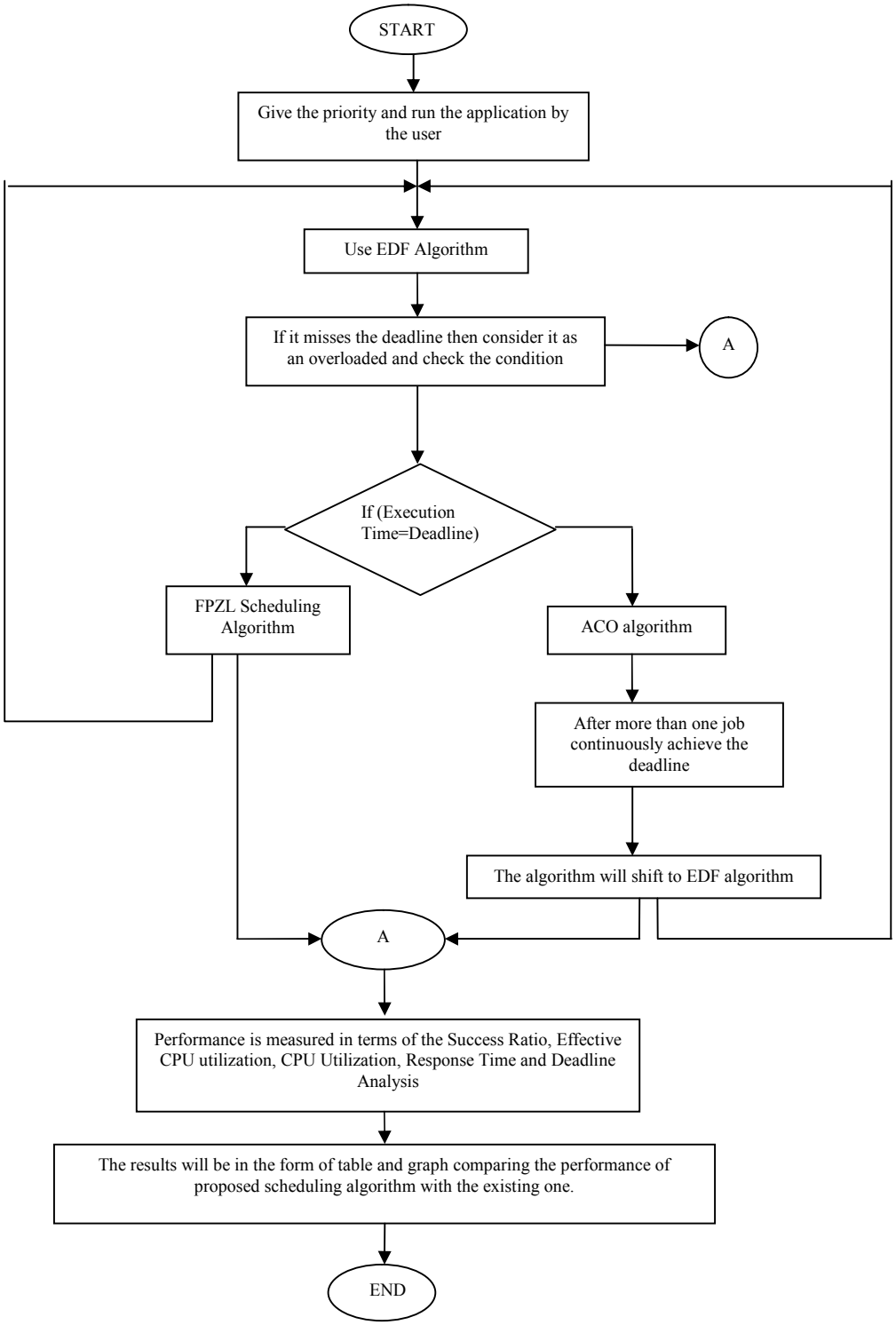

Figure 5: Flow chart of EDF-ACO algorithm

5. Conclusions

The adaptive algorithm is for scheduling of hard real-time system with single processor and preemptive task sets. The concept of EDF, ACO and FPZL has been introduced and combined this approach to get the adaptive scheduling algorithm. The advantage of the proposed algorithm is it will automatically switch between the algorithm and overcome the limitation of existing algorithms. The adaptive algorithm is very useful when future workload of the system is unpredictable.

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