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Energy Minimization with Fault Tolerance in the Real Time System

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Abstract
Real time system gives reliable results it's depends not only fault tolerance but also energy consumption in a system. Both are combination could easily find a reliability in the presence of faults. DVFS (dynamic voltage frequency scaling) is a technique which is used for energy minimization to adjust voltage as well as frequency depends on the processor behavior or available storage energy. Fault tolerance with energy minimization is a way to provide reliability in a system. In this paper, shows fault tolerance with energy consumption on using non-preemption scheduling. At the end of paper shows a graph comparison to any other fault tolerance algorithm.

Keywords
Aperiodic Task, Non Preemption, Checkpoints & DVFS.

I. Introduction

Real time system gives logically correct results in the presence of faults at their relative deadline. Sometimes deadline missed due to fault occurs & system becomes failure. Transient faults are more frequent than others faults. It can be appears just a seconds then sudden disappears no limit how many times are visible [3]. To overcome transient fault problems in a system using various time redundancy fault tolerance techniques. In this paper, apply checkpoints to prevent system becomes failures due to transient faults with a sufficient storage energy in a system.

We should have to uniformly distributed checkpoints before task's deadline & find a feasible task with minimizes energy consumption [5]. Before execution, without knowing worst case execution time & arrival time of each task applies jobs on non preemption EDF scheduling with fault tolerance or energy consumption & Find a schedubility or reliability in a system. DVFS is a dynamic voltage frequency scaling policy in which we have to adjust voltage levels as well as frequency levels of the processor according to available storage energy in a system with the help of this policy find minimizes energy consumption in the presence of faults [1], [2]. During execution, if system has sufficient energy for task execution then task is executed at full speed of processor else it can be executed lower speed o processor. DVFS policy is a aim to minimizes energy consumption in the presence of faults by adjusted voltages levels as well as frequency levels according to available storage energy. Voltage is directly proportional to the power of the system by using equation no 1.

$$P \propto V^2F \quad (1)$$

When vary voltage corresponding changes are also made in power of the system considering that phenomenon using DVFS policy & find minimizes energy consumption[6].

II. Related Work

For design a system with using fault tolerance or energy consumption in presence of faults. For that purpose considering many approaches, Linjie Zhu, designed a scheme for Multiprocessor with the help of fault tolerance or energy we can save energy up to 30% energy & reduce the miss ratio in the presence of faults[7]. Jian Jia, considered functional requirements slow down the functions based on their requirement to help for energy saving in a system[13]. & find a solution for DVS policy when we are apply on task synchronization in a system. Static or dynamic scheduling is considered on that scheme. We find a point where we have to modify frequency levels as well as voltage at which each task should be executed such that find minimizes energy consumption in presence of faults in a system. Sandra Djosic developed a FT-DVS algorithm & results sows that the proposed algorithm saved energy as compared when we are using fault tolerance capability without energy minimization[3]. Rami Melhem, in paper, explore scheduling slack time in a system it is helped to reduce energy consumption in presence of faults. Exploring scheduling slack in a system helps to reduce the processor speed at that time achieve fault tolerance in a system [8]. & results shows that when we are distributed non –uniform checkpoints in a system then based on that technique system can save energy up to 68%.

III. System Model & Problem Descriptions

System Model: - A set of independent aperiodic task T= $\{t_1, t_2, t_3 \ldots\ldots t_n\}$ where, t_1 is a aperiodic task it can be represented as t-(a_i, c_i ,d_i) where, a_i is representing arrival time of the task, c_i is representing computation time& d_i is representing deadline of the task. aperiodic task having irregularities in uniprocessor. During execution of task when fault occurs & then system becomes failure to recover that problem using fault tolerance time redundancy technique[4],[9]. In this paper using checkpoint time redundancy technique first, we should distribute uniformly checkpoints before task deadline. If a fault occurs during execution of task then first checked on nearest checkpoint in a system[10] [12]. & find checkpoints overhead r. r helps to find total worst case execution time for each task based on that find feasibility from equation no 2

$$WCET = C_i + k^* + m^* r + +k \quad (3)$$

To do any job in a system needs same energy. Energy depends on the processor behavior or usage of each job. DVFS is a policy of minimizes energy consumption in presence of faults. We have et is the total energy in a system it is usage by jobs & drain same energy for task execution [12]. Then available energy is find that calculated the difference between total energy or drain energy & easily find out available energy in a system. DVFS is a dynamic voltage frequency scaling in which we should adjust the voltage as well as frequency according to available storage energy in presence of faults in the system [11]. When voltage modifies corresponding

power is also vary by using equation no 1. In DVFS policy at starting of scheduling gives a full voltage for first task after that we are modify the voltage levels associated to task it is now working as half of the processor speed then checked task is works properly or not if yes then slowly do less speed f processor & find a point where task is completely schedulable then calculated the total energy at that point these process is known as DVFS.

Problem description- in this paper investigates a method of non preemption EDF scheduling for fault tolerance with energy minimization. Each task executed based on EDF scheduling end of scheduling calculated total worst case execution time from equation no before execution of the tasks, we should have to calculate sufficient optimal no of checkpoints for each task in a system then will start scheduling. After calculated total worst case execution time then find a point where can do adjust voltage levels as well as frequency levels in the presence of faults according to available storage energy in a system. Calculated total energy consumes by each task & for that purpose develops an algorithm find method for fault tolerance with energy minimization in a system.

Proposed algorithm

1. Start
2. Set all task t = 0
3. All task; s deadline arranged into non decreasing order
4. Find smallest deadline D_i is amongst deadline of the tasks.
5. If ($d_i \geq e_i$) then
   Task maybe schedulable
   goto step no 7
   Else task will not be schedulable
   Go to step no 6
6. find a fault & then recovered by using checkpoints
   WCET= C_i + k* + m* r + +k
7. Calculates total energy consume by schedulable task in a system by using DVFS policy
   $E_T = P_c + P_f$
8. IF (WCET $\leq d_i$ - ai)
9. Then task completely schedulable
10. Else go to step no1
11. exit

Above given a proposed approach proves that system works as a reliable system when we works do sufficiently for fault tolerance with energy minimization. At line 1 shows starting of algorithm. in line 2 considers all the tasks are having a relative deadline at t=0.. According to their relative deadline tasks are arranged non decreasing order scheduled according to EDF at line 5. If task are schedulable according to EDF then go to step no 7 & then find energy consume by that task. else task will not be schedulable then go to step no 6 & find a fault occurs or not if yes then recovered by checkpoints fault tolerance time redundancy technique, calculates WCET & then go to next step of algorithm. Otherwise go to step no 10. At line no 8 shows a condition if condition is satisfied by task then task is completely schedulable else not.

IV. Energy Consumption

To vary frequency levels according to available voltage & find a point where task is scheduable or at that point find power saving percentage using $P \propto V^2 F$ that equation for each task in a system. Below given shows a table in which wcet is changed or decrease from the previous value according to vary frequency levels. We have seven tasks for first task executed at full speed. Then apply DVFS policy vary frequency levels according to available storage energy & getting minimizes energy consumption in a system.

Table1: Power Saving % for Existing Algorithm

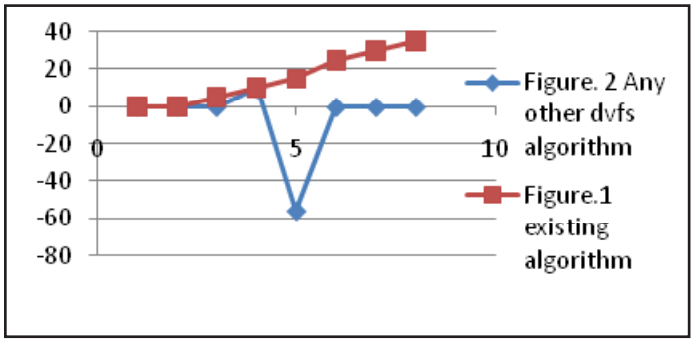
Frequency levels (x-axis)	WCET1	Scheduable or not	VOLTAGE	Power saving(y –axis)
1	5	YES	220	0
.95	5.26	YES	209	5
.9	13.33	YES	198	10
.85	18.82	NO	187	0
.75	18.67	NO	165	0
.7	25.71	YES	154	30
.65	26.15	YES	143	35

Given above shown a table for existing algorithm. Same as develop for any other algorithm. Below table 2 represents for any other algorithm.

Table 2: Power Saving & For Any Other Algorithm

Frequency levels (x-axis)	WCET2	VOLTAGE	Scheduble Or Not	Power Saving% (Y-Axis)
1	10	22O	no	o
1	12.6	220	no	0
.9	20	198	yes	10
1.56	25.88	343	yes	-56
1	33.33	220	no	0
1	42.8	220	yes	0
1	53.84	220	yes	0

After that draw a graph using we are easily find which one algorithm is best by comparison between existing algorithm and any other algorithm. .



Graph 1: Comparisons between existing algorithm and any other algorithm for power saving %. Below graph shows existing algorithm is power saving % is greater than any other algorithm.

V. Conclusion

Previously existing fault tolerant-dynamic voltage and frequency scaling algorithm generally works on power minimization .In EDF algorithm there is no more concern about fault tolerant capability of real time system. So our main concern is to minimize power consumption along with fault tolerance capability. As we deal with aperiodic tasks so we use the concept of checkpointing to minimize

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the response time of processes. For faults that are incurred or we can say detected by the Real Time System we just use the concept of re-execution of these faulty tasks. As this is the most inexpensive way to recover faulty tasks. We just used our proposed algorithm FTTSA algorithm to execute tasks within their given deadline such that to maximize the fault tolerant capability of the real time systems. Our future concern is to use various fault tolerance algorithms to check their capability to handle faults in the Real Time Systems.

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