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Adaptive Neuro Fuzzy Scheduler for Real Time Task: A Review

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Abstract- In a real time system contained various type of scheduling algorithms. They are used for determine which processes should be executed by the CPU when there are different processes to be executed. Neuro fuzzy logic approaches are very effective for scheduling real time task. This paper presents a review on scheduling algorithm of real time task. Then, discuss the limitations of EDF algorithm and features of neuro fuzzy system. We proposed neuro fuzzy scheduler using EDF to overcome the drawbacks of other algorithms for better scheduler performance of real time task.

Keywords- Neuro fuzzy logic, EDF, scheduler, task, process.

I. INTRODUCTION

Today, real time systems play an important role with the development of multimedia, embedded systems, mobile computing. Real time system required exact time for complete a job, if job do not complete in fixed time it may cause failure of the entire system. In real time system, job schedule in fixed time called deadline. Scheduling real time system involves tasks, processes, threads, or dataflow are given access to system resources. There are two main types of real time systems soft and hard real time system. In hard real time system meeting all deadlines is obligatory, while soft real time system missing same deadline is tolerable. Real time scheduling is divided into two types static and dynamic scheduling. In static scheduling all real time task schedule offline, using static parameter, in dynamic scheduling task scheduler calculate the feasible schedule online and allows tasks to be invoked dynamically[6],[16].

Scheduling is determining which tasks run when there are multiple runnable tasks. These tasks can be classified as periodic or aperiodic. A periodic task is schedule at regular interval of time and aperiodic task schedule unpredictably [6]. The use of neuro fuzzy systems is growing rapidly in many areas including process control, engineering design, financial trading credit evaluation, medical diagnosis, and cognitive simulation[18]. Integrated neuro-fuzzy systems can combine the parallel computation and learning abilities of neural network with the human like knowledge representation and explanation abilities of a fuzzy system. As result, neural network become more transparent, while fuzzy systems become capable of learning [23].

In this paper, we proposed neuro fuzzy scheduler for real time task using EDF scheduling algorithm. The remainder of this paper is organized as follows: section 2 introduced related works of EDF, Neural Network and Fuzzy Logic in real time system. Section 3 contained objectives of scheduling policy and different scheduling algorithms. Section 4 described designing neuro fuzzy system and feature Section 5 discussed limitations of EDF algorithm. Section 6 concludes this paper.

II. RELATED WORK

The following sections show the work done by the various researchers in the field of scheduling for real time processors. Zhi Quan [25], have proposed a simple and scalable analytical framework for determine the violation probabilities of an EDF scheduler with Gaussian flows. This framework significantly improves the result on EDF scheduling. Xiangbin Zhu [24], proposed fuzzy control theory based on EDF algorithm. When system is overloaded misdeadlines will produce. He introduced adaptive fuzzy controller theory will reduce the changes of misdeadline ratio. And show via simulation adaptive EDF algorithm has good performance when CPU utilization larger than 1.

Dario Faggioli, Michael Trimarchi, Fabio Checconi [4], implemented Efficient EDF in the form of a general purpose operating system. They introduced Stander EDF scheduling policy within Linux Kernel, and result shown that real time task may specify a minimum inter arrival time and worst case execution time.

Jinkyu Lee, Kang G. Shine [12], proposed controlled preemption (CP) which controls the condition of preempting jobs for better EDF schedulability. The preemption policy determines when a higher priority job can preempt a currently executing lower priority job. Fully preemptive EDF (fp-EDF) is not always optimal. Non-preemptive EDF (np-EDF) is ineffective in that a higher-priority job may miss its deadline when it is blocked by a lower-priority job.

Sanjoy Baruah, Shelby Funk, Joel Goossens introduced [20], EDF scheduling upon uniform multiprocessor is robust with respect to both job execution requirement and processor computing capacity.

Jagbeer Singh, Bichitrananda Patra, Satyendra Singh [10], have proposed Earliest Feasible deadline first (EFDF) algorithm to reduced time complexity of EDF. They analyzed EFDF algorithms have least complexity. EFDF algorithm reduced the time complexity in compression of EDF algorithm on real time system scheduling for multiprocessor system.

M.Kaladevi, Dr. S. Sathiyabama [16], have discussed real time scheduling algorithm and compared two important task schedulers such as EDF and Ant colony optimization (ACO) scheduler both are preemptive algorithm. Comparison based on load successive ratio and CPU utilization when load<=1, both algorithms are equally optimal. If it is compare according to execution time, EDF take less time than ACO based algorithm during under loaded condition.

Karsten Albers, Frank Slomka [13], have proposed new feasibility tests for uniprocessor real time scheduling using preemptive EDF scheduling. The new EDF test is compared with previous well known tests. New feasibility EDF tests are exact and outperform by previous tests.

Marko Bertogna, Sanjoy Baruah [15], have proposed limited preemption real time scheduling algorithm. Because if preemption occur runtime overhead increase during execution. Preemptive EDF is an optimal scheduling algorithm for single processor systems, hence they derived limited preemption EDF scheduling algorithm to reduced runtime overhead.

Shatha J. Kadhim and Kasim M, AI-Aubidy [21], have shown that fuzzy based scheduling algorithm useful for scheduling problems. They compared SJF, priority scheduling algorithm and fuzzy based scheduling algorithm. Next they presented via simulation comparison between parameter such as average waiting time and turnaround time in the fuzzy scheduling algorithm are better than that obtained using priority scheduling and SJF. They also proposed fuzzy decision maker which describe the relationship between measured variables and calculated output.

Mojtaba Sabeghi et al. [17], used fuzzy logic algorithm to multiprocessor real time scheduling. Take two different fuzzy parameter, deadline and laxity. He has shown using deadline as a fuzzy parameter in multiprocessor real time scheduling is more promising than laxity.

Sadasivam Sudha, Keppangowder Thanushkodi [22], has developed genetic algorithm based neuro fuzzy technique for process grain sized in scheduling of parallel jobs with the help of real life workload data. His result shown Genetic Based Neuro Fuzzy technique can be used as a better optimization tool for optimizing any scheduling algorithm and this optimization tool is used in agile algorithm which is used for process grain scheduling of parallel jobs.

Sandra G. Dykes et al. [19], proposed a system in which users define dynamic, application-specific, scheduling policies using a fuzzy-logic approach based on natural language rules. Distributed real-time applications require efficient scheduling to improve processor and network utilization to avoid missing task deadlines.

Guang-Bin Hauang, Qin-Yu Zhu, Chee-Kheong Siew [5], proposed a simple learning algorithm capable of real time learning which can automatically select values of neural quantizers and analytically determine the parameters of the network at one time only.

Hamidreza Rashidy Kanan, Mahdi Yousefi Azar Khanian [7], have discussed a major problem of neural network in real time applications such as long training time. To reduced neural network learning time he proposed adaptive fuzzy control system with neural network by using this system vary learning parameters and reduce training time in real time application.

Kothali et al. [14], proposed neural network based job priority assigner system for a job scheduling environment. Back propagation Neural Network-based priority procedure would recognize jobs from a job queue by defining each job's priority.

III. OBJECTIVE OF SCHEDULING ALGORITHM

Many researchers have work in the field of real time scheduling and it has been observed that, [9]

- **a.** Scheduling of process should be done fairly and throughput must be maximum.
- **b.** Pre-emptive real time scheduling algorithms are always performing better than non-preemption.
- **c.** Scheduling real time task in static priority scheduling algorithms for maximum CPU utilization but it can be increased more using dynamic priorities.

TYPES OF SCHEDULING ALGORITHM AND THEIR ADVANTAGES AND DISADVANTAGES

There are some parameters that scheduling algorithms aim to fulfil. These includes; throughput, turnaround, response time, and waiting time. There are many scheduling algorithm such as round robin, first come first served, shortest job first least laxity first, rate monotonic, deadline monotonic, earliest deadline first[6].

Round Robin (RR): RR gives every process with the same priority set share of time before making a context task, when all tasks have got their time share. The first task gets back into the CPU for its next processing. The advantages of RR algorithm is simple, low overhead, good interactivity. The disadvantages of the algorithm is, it include the absence of priority system. If quantum is too small, too much time wasted in context switching [8].

First-Come-First-Served (FCFS): FCFS algorithm selects the task with the earliest arrival time. If system contains periodic tasks, their release time will be considered. This algorithm makes no effort to consider a task's deadline [6]. The advantages of FCFS algorithm is simple and low overhead. The disadvantages are inappropriate for interactive systems, maximum turnaround time, and low throughput [8].

Least Laxity First(LLF) : LLF algorithm selects the task that has the lowest laxity among all the ready ones whenever processor become idle, and executes it to completion. This algorithm is non preemptive and executes it to completion. The advantages of LLF are to decide which task should execute next at the schedule time and assigning fixed priorities to the task at development time. The disadvantage of the algorithm is it gives the poor runtime behaviour [11].

Rate Monotonic (RM): RM algorithm sets priority level for each task in order of their period length; tasks with short periods will get a high priority while task with long periods gets low priority. High priority task then take precedence before lower priority tasks. RM algorithm is easy to implement and optimal among fixed priority schedulers. The disadvantage of RM algorithm is it may not give a feasible schedule even if processor is idle at some points [8].

Deadline Monotonic (DM): DM assigns priorities to tasks according their relative deadlines. The shorter the relative deadline, higher the priority. The disadvantage of DM is not optimal for fixed priority non-preemptive scheduling [3].

Earliest Deadline First (EDF): EDF algorithm schedule the task with the earliest deadline.EDF is the dynamic scheduling algorithm which places the task in apriority queue. The priority is assign at run time depending upon the deadline. A Task is schedulable under EDF, if and only if it satisfies the condition that the total processor utilization due to task is less than 1.EDF is simple as well as optimal algorithm [3].Fig.1 shows basic working of EDF algorithm.

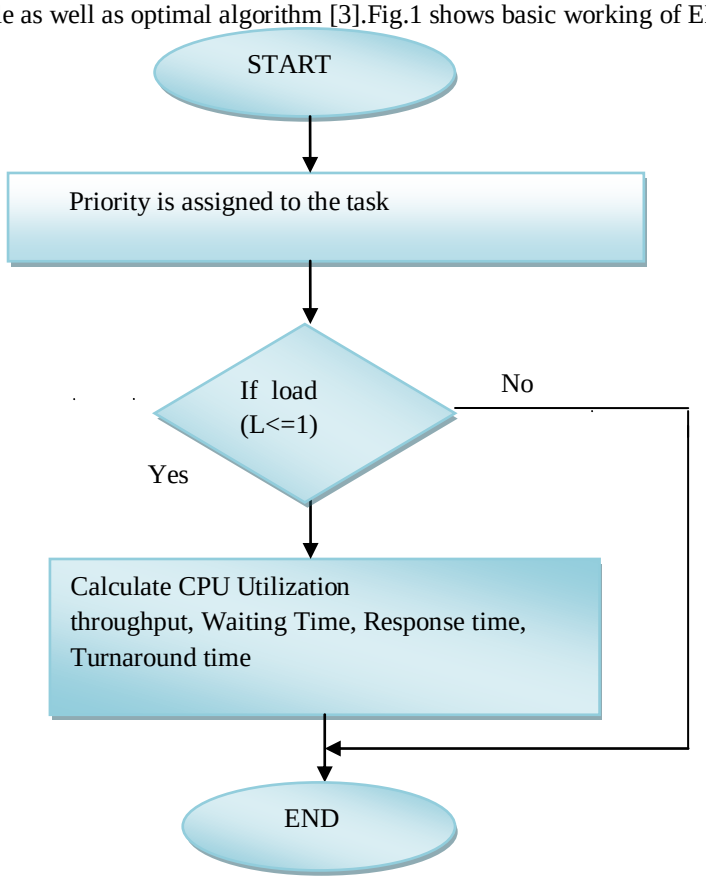

Fig.1 Basic working of EDF Algorithm

In real time system, applications of EDF have brought some problems. When EDF algorithm implemented in hard real time system there aren't any overloading conditions. But when EDF algorithm worked in soft real time system overload condition occurs. EDF algorithm decreases the performance when system overloaded. The first problem is, it is difficult to predict which task will miss their deadlines during overloads. Next problem is a late job which has already missed its deadline has a higher priority than job whose deadline is still in the future [24].

IV. DESIGN OF NEURO FUZZY SYSTEM AND FEATURE

Neural network are good at recognizing patterns, they are not good at explaining how they reach their decisions. Fuzzy logic systems, which can reason with imprecise information, are good at explaining their decisions but they cannot automatically acquire the rules they used to make those decisions. Hence we incorporate the concept of neural network into fuzzy logic. The resulting system is called neuro fuzzy system [18]. Following table I represents comparison between neural network and fuzzy inference system [1].The attractive features of an adaptive neuro fuzzy system include, easy to implement, fast and accurate learning, strong generalization abilities, excellent explanation facilities through fuzzy rules, and easy to response both linguistic and numeric knowledge for problem solving [2].

Table I. Comparison between neural network and fuzzy inference system

Neural Network	Fuzzy Inference System
Prior ruled based knowledge cannot be used	Prior ruled based cannot be incorporate
Learning from scratch	Cannot learn (using linguistic knowledge)
Black box	Interpretable (if-then- rule)
Complicated learning algorithm	Simple interpretation and implementation
Difficult to extract knowledge	Knowledge must be available

The possible neuro fuzzy system model is shown in figure (2) [18]. Fuzzy interface contained linguistic statements which provide an input vector to a multi-layer neural network. The neural network can be adapted to get desired outputs or decisions.

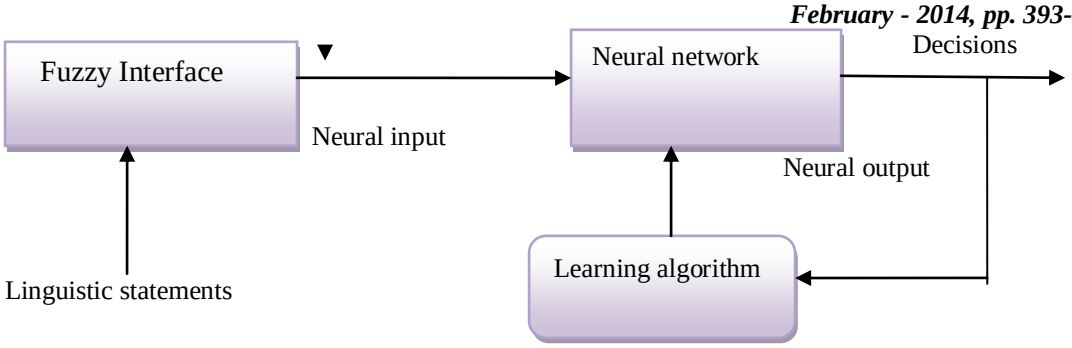

Fig.2 Model of neuro fuzzy system

V. LIMITATIONS OF EDF ALGORITHM

From above related work it can be seen that EDF algorithm have some limitations.

EDF is not optimal for non-periodic, non-preemptive jobs with arbitrary arrival times also it is not optimal for periodic, non-preemptive jobs [12], [3]. EDF is not optimal for multiprocessor scheduling [20]. EDF behave poorly under overload. EDF needs priority queue for storing deadlines. EDF is less predictable. EDF have less control over the execution. Implementation of EDF relatively complicated [3].Hence to overcome limitation of EDF scheduling algorithm is a challenging problem in designing neuro fuzzy scheduler.

In proposed work, we implement EDF algorithm. EDF can be implemented by maintaining all ready tasks in sorted priority queue depending on its deadline. Whenever processor becomes free then by using EDF scheduling algorithm, according to priority queue shortest deadline task will be assigned to the processor. At the same time longer task waits in a ready queue. In that case, any new task arrives; its deadline will be checked with the deadline of currently executing task, if deadline of newly arrived task is closer to the current time, it will get chance for scheduling. And old task will be preempted and placed end of the queue [10], [20]. In this EDF scheduler we used neuro fuzzy technique. In that process, we apply most common algorithm is backpropagation learning algorithm. In our approach, we used Learning algorithm to train EDF task scheduler. Learning algorithm is used to make the scheduler adaptive. Also Learning processes reduce development time and cost while improving performance. This adaptive neuro fuzzy learning algorithm will be useful for handling the limitations of simple EDF algorithm. Adaptive EDF will be helpful to improve performance of system.

VI. CONCLUSION AND FUTURE WORK

In this paper, we have reviewed the most of the research papers based on EDF scheduling. We discuss objective of scheduling algorithm, types of scheduling algorithms with their advantages and disadvantages. In this paper, we discussed neuro fuzzy system with its feature and also discussed various limitations of EDF algorithm. In future work, we are designing adaptive neuro fuzzy scheduler for real time task, using EDF scheduling algorithm and improve parameter performance of real time system.

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