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Fuzzy Scheduling Algorithm for Real –Time multiprocessor system

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Abstract: In a multiprocessor environment scheduling is very essentially done with greater challenges. Researchers are in the edge of finding solutions to these challenges. Scheduling is the art of allocating limited resources to competing tasks over time. A feasible schedule satisfies the constraints that are associated with any particular set of tasks and resources. So as to improve the performance of the . The problem is generally NP-Complete and is not easily solvable. Many techniques are applied like Fuzzy and Genetic algorithms. In this paper we are proposed a scheduling algorithm to real time tasks using fuzzy technique.

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Index Terms—: Real-time systems, Fuzzy Inference system, Fuzzifying, Defuzzifying, CPU time, Deadline, Communication Overhead.

1 INTRODUCTION

Real-time systems are the "information processing sys tems where the system responds to input stimuli within a finite and specified period". In these systems the correctness of a computational units and the time at which results are produced is very important.
Real-time systems are essential to industrialized infrastructure such as command and control, process control, flight control, space shuttle avionics, air traffic control systems etc. [1, 4]. Such a system must react to the requests within a fixed amount of time which is called deadline. In general, real-time systems can be categorized into two important groups: hard real-time systems and soft real-time systems. In hard real-time systems, tasks need to follow strict adherence to deadline constraints. On the other hand in soft real-time systems missing some deadlines is tolerable. Tasks can be classified as periodic or sporadic. A periodic task is a kind of task that occurs at regular intervals, and an aperiodic task occurs unpredictably. The time interval between the arrivals of two consecutive requests in a periodic task is called period [1].

In a multiprocessor system, the limited resources consist of one or more processors which can be identical or distinct with respect to function and speed. Real –time tasks are characterized by their computation time, ready time, and deadline, etc [21]Real-time scheduling of periodic tasks on multiprocessors can be either on homogeneous or heterogeneous processors. Example algorithms on homogeneous are Rate monotonic (RM) and Earliest deadline first (EDF). The two main approaches for all the ready tasks are placed in a queue and sorted based on priority. The task with the highest priority, which is first in the queue, will be selected by the scheduler and will be executed on one of the processors. During the execution task may be preempted or migrated if necessary. In partitioning, each task is assigned to a single processor, on which each of its jobs will be execute and are scheduled independently
The rest of the paper depicts the journey as follows: Section 2 describes literature survey, in section 3 proposed models is described and conclusion section 4 gives discussion about future work.

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2. LITERATURE SURVEY

The degree of satisfaction can be used as a parameter for making a decision, which is achieved by using Fuzzy technology. Fuzzy logic is an alternate to Boolean logic, the degree of truth is applied to observe the imprecise modes of reasoning that plays an important role in decision making ability in the atmosphere of uncertainty and imprecision.
Fuzzy Inference System (FIS) [2] consists of three steps: input step, a processing stage, and an output step. The input stage receives inputs like deadline, execution time, response time and so on, and maps these to appropriate membership functions and truth values. In the processing step each appropriate rule is invoked and the corresponding result is generated. Then results are combined so that it will be given as an input to the output stage. In output stage converts the combined result is converted back into a specific value.
The membership function of a fuzzy inference system depicts a curve which defines how each point in the input space is mapped to a membership value or a degree of truth value between 0 and 1.
The most common shapes of a membership function are triangle, trapezoidal and bell curves.

The processing stage of an inference engine is based on a collection of logical rules in the form of IF-THEN statements where the IF part is called the "antecedent" and the THEN part is called the "consequent". The knowledge base of the system has dozens of rules. An example of fuzzy IF-THEN rule is: IF deadline is catastrophic then priority is high, in which deadline and priority are linguistics variables and critical and high are linguistics terms. Each linguistic term corresponds to membership functions. The basic five steps applied in a fuzzy inference engine [10] are as follows:

- Fuzzifying inputs
- Applying fuzzy operators
- Applying implication methods
- Aggregating outputs
- Defuzzifying outputs

Fuzzifying the input is the process of determining the degree to which they belong to each of the appropriate fuzzy sets via membership functions. Once the inputs have been fuzzified the degree to which each part of the antecedent has been satisfied for each rule is known. If the antecedent of a given rule has one or more part, the fuzzy operator is applied to obtain one value that represents the result of the antecedent for that rule. The implication function modifies the output fuzzy set to the degree specified by the antecedent. Here decisions are based on the testing of all the rules in an inference system, the results from each rule must be combined in order to make a decision. In aggregation the output of each fuzzy set that represents the output of each rule is combined into a single fuzzy set. The input for the defuzzification process is aggregated output fuzzy set and the output is a single value. There are two common inference processes. The first one is called Mamdani's fuzzy inference method proposed by Ebrahim Mamdani [16] and the second one is Takagi-Sugeno-Kang, or simply Sugeno [17], method of fuzzy inference. These two methods are the same in many aspects, such as the procedure of fuzzifying the inputs and fuzzy operators. The main difference between Mamdani and Sugeno is that the Sugeno's output membership functions are either linear or constant but Mamdani's inference expects the output membership functions to be fuzzy sets. Sugeno's method has three advantages. First, it is computationally efficient, which is very important for real-time systems. Second, it works well with optimization and adaptive techniques. These adaptive techniques provide a method for the fuzzy modeling procedure to extract proper knowledge about a data set, in order to compute the membership function parameters that allow the fuzzy inference system to track the given input/output data. The third, advantage of Sugeno type inference is that it is well-suited to mathematical analysis.

3. The Proposed Model

In the proposed model, the input stage consists of three linguistic variables i.e. CPU time, deadline and communication overhead, as shown in Fig1. CPU time is the amount of time a task requires to execute a task. Deadline represents the final time limit within which task has to complete its work. Communication overhead is the time, how much a task spending in communicating with other task so has to complete its work. If the communication overhead is close to 1 then priority is low and if it is close to 0 then priority is high.

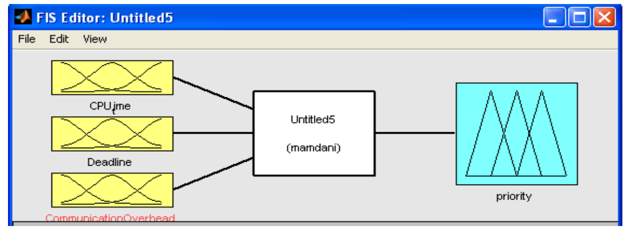

Fig.1.The proposed Fuzzy Inference Engine

Membership functions describe the degree to which each input parameter represents its association. Linguistic variables are assigned to each input parameter, to represent this association. CPU time can be classified as low, medium and high. Similarly communication overhead is defined in the same way. However deadline is defined as tolerable, sensitive and catastrophic as depicted in Fig.2. Fig.3 and Fig.4.

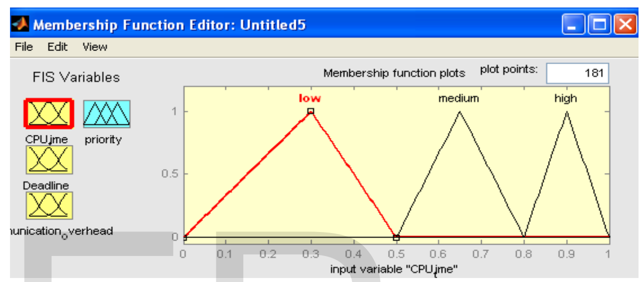

Fig.2. Fuzzy Set Corresponding to CPU time

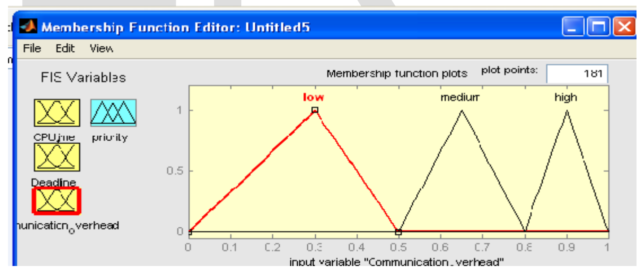

Fig.3.Fuzzy Set Corresponding to Communication overhead

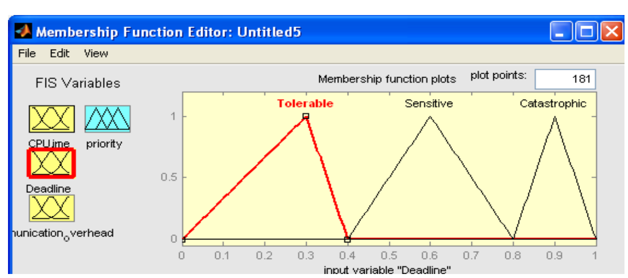

Fig.4. Fuzzy Set Corresponding to Deadline

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Fuzzy rules combine these parameters as they are connected in real worlds. Some of these rules are as follows:

IF (CPU time is low), (Communication overhead is low) and (Deadline is Tolerable), THEN priority is medium

IF (CPU time is medium), (Communication overhead is high) and (Deadline is Tolerable), THEN priority is low

IF (CPU time is high),(Communication overhead is medium) and (Deadline is catastrophic), THEN priority is high

In our proposed algorithm as given below, a newly arrived task will be added to input queue, which consists of tasks that has not yet been assigned to processor.

Loop

For each processor in the multiprocessor environment do the following:

1. For each ready task, feed its CPU time, communication overhead and Deadline into the inference engine. Consider the output of inference system as priority of task T.
2. Execute the task with highest priority until a scheduling event occurs (a running task completes , a new task arrives)
3. Update the system states.

4. Experimental results

If we choose more rules and member functions it will directly affects the overall system accuracy, even though performance of the system can be made better when number of rules are reduce. Technique like genetic algorithm for choosing rules from a set of rules may be considered, however this approach can discussed in future. The above considered rules decision surface and member functions is illustrated in the Fig.6

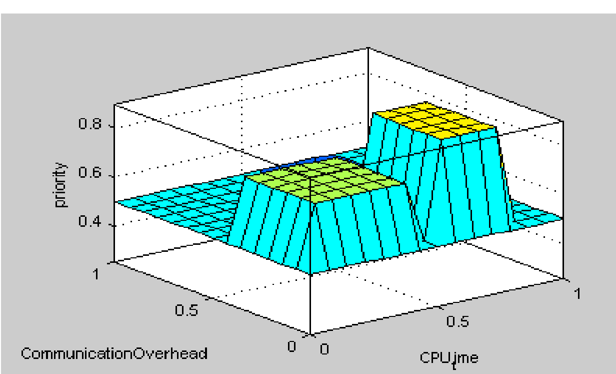

Fig.6. The decision surface Corresponding to Inference rules.

5. Conclusion

The scheduling algorithm proposed in the paper considered with deeper simulation by having more rules. The Overall system performance can be further made it better using hybrid technique which may be combine approaches of fuzzy and genetic techniques.

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