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New Fuzzy-Based Approach Using RED Algorithm for Multi Processor Scheduling

Mehdi EffatParvar[1], Hooshmand Alipour[2], Mostafa Khalili[3]
[1] Department of Computer, Ardabil Branch, Islamic Azad University, Ardabil, Iran
[2] Department of Computer, Parsabad Branch, Islamic Azad University, Parsabad, Iran
[3]Department of Computer, Germi Branch, Islamic Azad University, Germi, Iran

Abstract
This paper proposes a technique for load balancing on symmetric multiprocessor systems, where tasks are placed in queues for being processed. Load balancing on processers was run using the RED algorithm and fuzzy system. This system which involves three threads and load balancing was carried out based on these threads. Load balancing operation was carried out in symmetric processers. Load balancing aims to distribute loads equally on processers, enhance throughput, and reduce the delay. Besides, the major goal pursued by the advance systems is to drop the costs, minimize costs of adequate load balancing, and avoidance of unnecessary attempts in load balancing.

Keywords: *fuzzy approach, RED algorithm, Scheduling*

1. Introduction

Computers have been traditionally considered as a single-processor machine but the technological and computational advances have led to emerge of high speed parallel computers. Another factor resulting in development of parallel computers was the drawback of CPU. However, capabilities of the CUPs are constantly increasing, as presently desktop computers, laptops, and other advance technologies are equipped with multiprocessing system. The high speed data delivery and process in multimedia has posed some challenges against further computational performance. Symmetric multiprocessors and clusters are among the most common techniques of organizing the multiprocessors for improving their performance and accessibility [1]. Multiprocessor systems are highly compatible for processing tasks. Such ability, in turn, increases complexity of the multiprocessing systems and introduced many problems for these system; for example, synchronization, processor deficiency, and memory speed issues [1]. Presence of multiple processors results in complexity of decisions and introduces new opportunities. For instance, in processors with ready queues, the tasks are scheduled for being processed, where these processes can also lead to imbalance of the processor. Therefore, in this paper a fuzzy system and RED algorithm were proposed for load balancing on processors.
Load balancing in a given processor is run in particular range, since a given load balance should be carried out in a corresponding processor [3]. Load balance is among the most important characteristics during overhead of system tasks [8]. Once a part is excessively engaged, load can be switched to areas with less activity [8].

2. RED algorithm

When the sours are synchronized, all sources transmit the tasks simultaneously and delivery rate drops. In this case, bandwidth efficiency also decreases; for example, bandwidth is 100 MBP but only 20 MBP of it is used. This situation is not favored, since it is required to use all bandwidth capacity. Such a phenomenon, in which all sources increase and decrease the bandwidth rate simultaneously, is called as overall synchronization. In this regard, another important concept is fairness: fair distribution of data among the sources. This process is carried out using the “drop tail” method technique, where a set of buffers exist inside the sources. Whenever a queue is filled, the next data added to the queue would eliminate the previous data and replace them. This dropout of the sources will be informed by all data and as a result delivery rate is lowered. To solve such a phenomenon, some data are randomly deleted. In the case of critical situation, the data cannot be randomly deleted; however, if the

pack delivery is initiated sooner, they can be randomly deleted.

When a given queue is filled, it is required to delete its data since there exists no place for pack delivery. In other words, a particular limit is assigned for the queues; above which queue is crowded and as a result pack delivery should be dropped. This process can be performed using "the early random drop" technique. Here, RED is among the algorithms which applies the random drop procedure.

RED algorithms are used in CISCO routers. This algorithm divides the queue into several segments. Some parameters of this algorithm are as follows: MIN(TH): early threshold limit, MAX(TH): ultimate threshold, and MAX(P) which presents the curves.

Until queue length does not reach MIN(TH), everything is normal and no overhead is observed in the network and each pack can be placed in the queue and be processed. Once passing MIN(TH), the network is gradually crowded and sources transmit less sources. Moving from MIN(TH) to MAX(TH), system is more strict and once passing the MAX(TH) all data are eliminated. Performance of RED algorithm is represented in the following lines:

for each packet arrival

calculate the average queue size *avg*

if $min_{th} \le avg < max_{th}$

calculate the probability p_a

with probability p_a :

mark the arriving packet

else if $max_{th} \le avg$

mark all the arriving packet.

3. Fuzzy logic

Fuzzy theory and logic has been broadly studied in applications such as artificial intelligence, linguistic studies, logic, decisions theory, control theory, expert systems, and neural networks. Recently, research of Professor Lotfi-Zadeh in the field of fuzzy logic has been applied in various areas including software and hardware design and computer calculations based on words, computer intelligence theory in natural language understanding, as well as light and heavy industries [1]. The term "fuzzy" is defined in Oxford dictionary as: "indistinct, unclear, inaccurate, misty, distorted, nebulous, vague, hazy, etc. To deal with normal load balance problem, load theory can be applied for regain of system load balancing. Fuzzy logic can control the system based on data traffic [7]. Fuzzy system is established on a set of linguistic rules which are converted to linguistic variables using the linguistic values [2].

3.1 Performance of fuzzy logic

Linguistic variable and "IF-THEN" rules are among the characteristics of fuzzy logic when applying its basic rule structure. During fuzzy process, the controlling problems are converted to a set of "IF x And y THEN z" rules which respond to the desired output of the system based on the input data introduced to the system [1]. These simple and clear rules are applied for describing the desired response of system using some linguistic variables instead of mathematical formula. Interestingly, although fuzzy systems describe uncertain and unclear phenomenon, fuzzy theory is a precise theory. Linguistic variable is a variable with values such as words or sentences from a natural or manmade language. For example, consider age of an individual; if the values assigned to age are expressed using the words such as "child, adolescent, teenager, adult, and old", age is a linguistic variable [1].

Example: Speed of a given care is assigned as variable x which is placed in the range of [0, Vmax]. Now, we define three fuzzy sets of "slow", "medium", and "fast" and define them in the range of [0, Vmax]. If x is considered as linguistic variable, then it can take expressions "slow", "medium", and "fast" as its vales (Fig. 1).

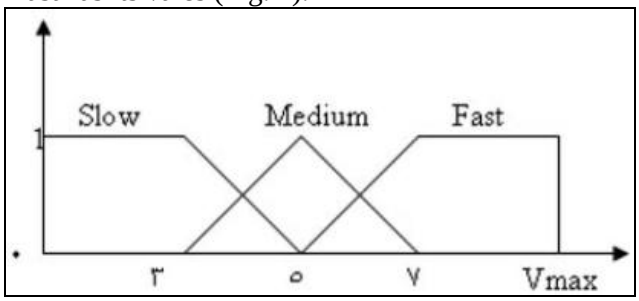

Fig. 1 A car's speed as a linguistic variable.

A given linguistic variable is defined using five components:

X: Name of linguistic variable;
T(x): Set of linguistic variables assigned by X;
U: Real physical range in which linguistic X variable can take its quantitative vales (reference set);
G: A grammar through which different linguistic values are produced; and
M: A linguistic rule which relates each linguistic value in T to a specific fuzzy set in U.
Therefore, introducing the linguistic variables enables us to formulate the vague and unclear descriptions of natural languages in the form of mathematical expressions. This is the first step for systematic and effective participation of human science in engineering systems.
In general, the term fuzzy implies "concepts without clear bound". Fuzziness means having multiple values and stands against two-value logic which predicts only two states (correct or false, white or black, etc.) for each question, concept, etc. Indeed, Aristotelian logic can be considered as particular state of fuzzy logic [1]. Fuzzy logic believes that there is some ambiguity in the nature of science. Unlike others who believe that the approximations are required to be more accurate for enhancing the productivity, Lotfi-Zadeh claims that it is necessary to design some models which simulate fuzziness as part of a system [1].
Fuzzy model is a new technology which completes and replaces the traditional design and modeling methods of a given system which requires advance and rather complicated mathematics with linguistic values and conditions and, in other words, expert's knowledge for the sake of simplification and higher efficiency of system design. Fuzzy logic believes that fuzziness places in the nature of science. Fuzzy logic believes that there is some ambiguity in the nature of science. Unlike others who believe that the approximations are required to be more accurate for enhancing the productivity, Lotfi-Zadeh claims that it is necessary to design some models which simulate fuzziness as part of a system [1].Aristotelian logic consists of "true" and "false" categories [1]. Load balancing on processor is executed in a given processing range. Since a load balance is required to be performed in a balanced processor, the task is performed in processing unit which contains the processor [2].

3.2 Fuzzy logic method applied in load balancing algorithm

This fuzzy system, which is placed in Kernel, contains three convertors including information recovery conversion, fuzzification conversion, and logic module. Here, fuzzification is not required since the output values of load balance fuzzification are whether used or not. Due to the specific requirements of this Kernel, fuzzy system is force to simplified the calculations and minimize the use of memory sources [1].
Fuzzy logic can be used in expressions technology in the form of approximate inference for supporting the rules. Theoretically, fuzzy logic is a method which presents analog processes [4].
Fuzzy algorithm is among the several effective methods for load balance when the tasks are highly unstable and unpredictable [5]. The input parameters of this algorithm are the overall load of prepared data rows and number of commands in a given prepared data row. The dynamic range of input variables are divided into three segments (i.e., membership functions or levels): small, normal, and big. Here, triangular and trapezoidal functions are selected because of their minimum unnecessary calculation cost requirements and fast decision making process. The observations from measured data for both functions are applied in definition of membership function [1].
Membership functions are prepared for the overall load of data queues. The term "small" defines a range in which the total load of all prepared data queues is that much small which requires no load balancing. In other words, there is none or few commands in the system [1]. The term "normal" defines a range within which the loads are not high and if this load is fairly distributed, each processor must have at least several commands in its data queues. Finally, the term "big" indicates a range in which there exists a large number of commands in the system [1].
The main reason for developing fuzzy logic from fuzzy set theory is to form a conceptual framework for linguistic sciences. Reasoning process can be done either using composition-based or individual-based inference. For composition-oriented case, all rules are combined together using a clear relationship and then mixed with a fuzzy input whereas for the second case, individual-based state, each of these rules are independently mixed with the new input.

In this work, individual-oriented approach with Mamdani function was applied. Such a choice was made because of its easier implementation because the results are adequate for both methods. The embedded new fuzzy system for load balancing applies two input parameters including: number of commands in each data queue and entire load in the ready data queues. This system is designed for load balancing of the processors in multiprocessor system. The preliminary objective of this advance system is the fast adaption of dynamic load, minimal computational overhead, fair load balancing, and avoidance of unnecessary load balancing attempts [1]. Within the fuzzy logic, commonly called as "logic", a complete thread of real values are not available for the logic expressions. Rather, fuzzy logic is a weak joint to theory and probability [6].

4. Proposed method

Load balancing operation on processors was performed using the target of RED algorithm on fuzzy. Through this procedure three steps are developed and load balancing operation is performed in these steps. Processors have ready queues which deliver tasks for processing. The tasks, in turn, wait in queues for delivering the processors. To have equal tasks for all processors and execute processing operations, load balancing operation is used. As previously mentioned, the ready queues in the processors are formed of steps, where these steps consist of SMALL, NORMAL, and BIG segments.
In SMALL thread, task queues for processing are short and load balancing does not occur. In NORMAL thread, the queue is not busy, processors execute task processing, and there is no need for load balancing. In BIG thread, once moving from NORMAL towards BIG, the queue is busy, data transfer is decreased, and load balancing operation occurs.
As shown in Fig.2, the following 9 threads are developed through these three steps:

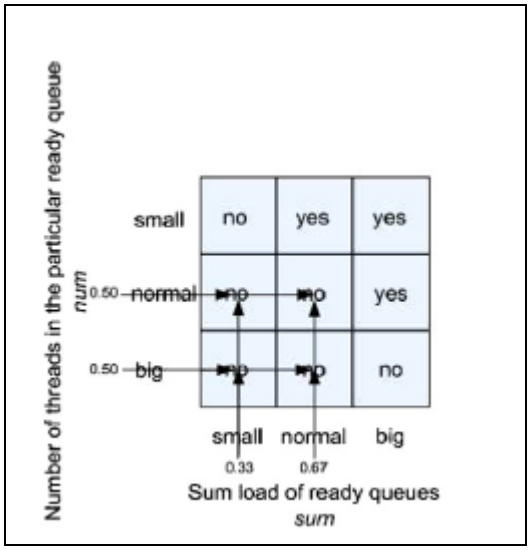

Fig. 2. Load balance on tasks waiting in queue of processors

Y and X axes present length of threads and number of ready loads in queues, respectively.
There is no load balancing operation In SMALL threads with small load queue, NORMAL threads with small LOAD, BIG threads with small LOAD queue, NORMAL threads with NORMAL LOAD queue, BIG threads with NORMAL LOAD queue, and BIG threads with BIG LOAD queue. On the other hand, for SMALL threads with NORMAL LOAD, SMALL threads with BIG queue length, and NORMAL threads with BIG LOAD queue, load balancing operation occurs on processors. In this state, load transfer is gradually decreased and in the case of load overhead, no load is transferred to the queue of processors for processing operations.
The main objectives of developed load balance system is fast adaptation of dynamic load, minimizing the costs, adequate load balance, and to avoid unnecessary attempts. RED algorithm, which has MIN(TH) and MAX(TH), if the number of transferred tasks is in the range of [0, SMALL], no event occurs. But if it moves from SMALL toward BIG, data transfer is reduced. Finally, if it exceeds BIG, data transfer is completely blocked.

5. Simulation results

In this part, the obtained results from the proposed method are evaluated and discussed. It must be noted

that all simulations were executed in MATLAB environment. Here, we analyze our model using the LPT and SPT algorithms. Fig. 3 and Fig. 4 present idle time for task scheduling, which are 200 and 2000, respectively.

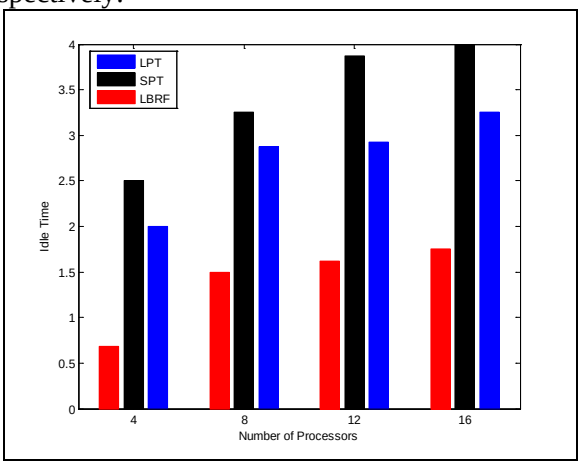

Fig. 3. Idle time of the processors (number of tasks and processors are 200 and 16, respectively)

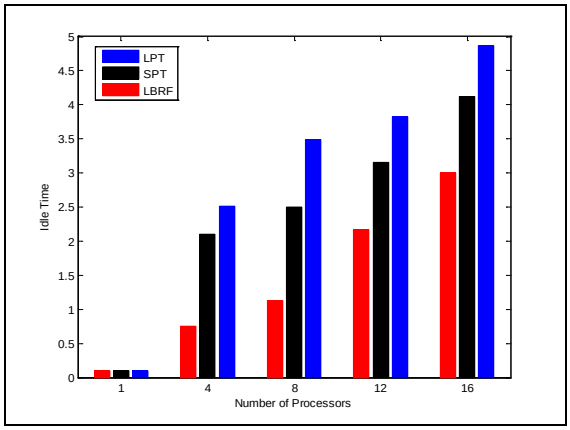

Fig. 4. Idle time of the processors (number of tasks and processors are 2000 and 16, respectively)

Fig. 5 presents system utilization when there are 200 tasks. As shown in the figure, system utilization is improved using the proposed method, as compared to other algorithms. This improvement can be attributed to the fact that the proposed method offers a fair load distribution for various sources.

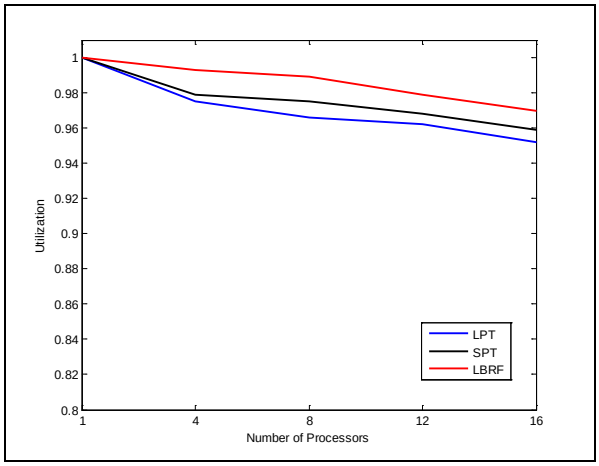

Fig. 5. Processor utilization (number of tasks and processors are 200 and 16, respectively)

In addition, Fig. 6 presents system utilization for the case of 2000 tasks. The figure shows that also under these conditions, the proposed method offers better results as compared to LPT and SPT algorithms. Based on the obtained results, it can be claimed that the proposed method enhances system utilization, results in fair load distribution in different sources, and minimizes the idle time.

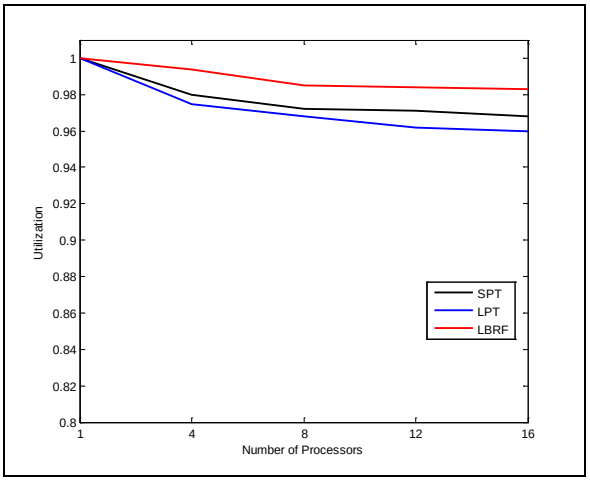

Fig. 6. Processor utilization (number of tasks and processors are 2000 and 16, respectively)

6. Conclusion

In this paper, a model was proposed for load balancing on symmetric multiprocessor systems, where load balance was carried out using the RED

algorithm. If task transfer exceeds its limit on processor, data transfer rate is dropped with respect to the receiving capacity of the processors. If data transfer exceeds its predefined limits, data transfer is blocked and transfer process is executed by processors with smaller number of tasks to be done. This work was conducted based on a RED algorithm on fuzzy logic on symmetric processors.

References

[1]Mika Rantonen a, TapioFrantti b, Kauko Leiviskä c Fuzzy expert system for load balancing in symmetric multiprocessor systems (2010) ScienceDirect.

[2] Yu-Kwong Kwok and Lap-Sun Cheung ,A new fuzzy-decision based load balancing system for distributed object computing$,Received 24 September 2001.

[3] M. Corrˆea, R. Chanin, A. Sales, R. Scheer, A. Zorzo Multilevel Load Balancing in NUMA Computers Technical Report Series Number 049 July, 2005.

[4] Matematika, 1999, Jilid 15, bil. 2, hlm.95{109°c Jabatan Matematik, UTM. Fuzzy Logic Model for Dynamic Multiprocessor Scheduling

[5] A fuzzy logic approach to load balancing in augmented reality distributed environments - Udini.htm (2012).

[6] R. Rojas: Neural Networks, Springer-Verlag, Berlin, 1996.

[7] http://www.modiryar.com/index-management/general/reseach/4692-1391-01-30-07-45-51.html.

[8] POWER LOAD BALANCING USING FUZZY LOGIC SaumilNavalbhai Patel B. E., Gujarat University, India, 2007.