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Study on Task Scheduling of Heterogeneous Multi-core Processor Based on Improved Shuffled Frog-leaping Algorithm

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ABSTRACT: In the current environment, for the conflicts and problems of related tasks scheduling in environment of heterogeneous multi-core processor, at the same time, in order to take into account the heterogeneous multi-core processing platform's advantages taken into full play, so the re-allocation of ISFLA algorithm happens. This improved algorithm based on heterogeneous shuffled frog-leaping algorithm, a new encoding system established through additional individual, combined with the location information to realize search for spatial information to discrete space mapping. The task scheduling algorithm based on heterogeneous processors, and the algorithm set analysis of the whole subgroup, which effectively avoid the sudden abnormal phenomenon of discrete space group in the state of stagnation difference, and significantly improve the processor stability and computational efficiency, and achieve a number of applications of the standard SFLA algorithm in heterogeneous multi-core's environment. In addition, the algorithm also introduces the genetic tree crossing algorithm, in order to optimizing the transmission structure of the population distribution of global population information diffusion,which strengthening the local optimal value level and local search ability. Generally speaking, this kind of improved heterogeneous multi-core accounting method can be used in the process of solving the operation, and the implementation of the number of layers to provide a better scheduling that has very good application prospects.

INTRODUCTION

The current development trend of the processor, heterogeneous processors occupy the main development market. On the one hand, due to its excellent computing performance, on the other hand, the heterogeneous processor also has a large development space. Therefore, at present, on the heterogeneous multi-core computing platform, efforts made to solve the minimum running time of processor and data required for cross shunt or maximum output weights of performance breakthrough of the task allocation process, which decides the degree of the performance of multi-core processor. This is the famous NP-hard problem, which is how to obtain optimal solution in polynomial time. Most of the current research of the algorithm based on heuristic algorithm program, while the improved particle swarm optimization algorithm based on heterogeneous platform to realize independent task scheduling, and solves loop knot problem of local optimal solution of heterogeneous algorithm using genetic algorithm obtaining task scheduling programs, and it is gradually applied on heterogeneous multi-core platform where include scheduling of periodic tasks and cross operation models.

1 Model program of heterogeneous multi-core scheduling

This paper mainly focus on the analysis and efficiency comparison of various tasks scheduling problem on heterogeneous multi-core processor platform. Typically, this kind of multi-core processor system is mainly used to match the task model of constraint relation in the process of task scheduling, and the DAG is used to describe the relationship of various constraints. Take the general formula, which is based on existing m core processor and n related tasks, the system model is composed of a five element array that is set as S. It is S= (P, L, T, E, C), in which:

P={P1，P2，P3……，Pm}meaning the processor with m heterogeneous cores, each of which is corresponding to each of the elements and the processor core.

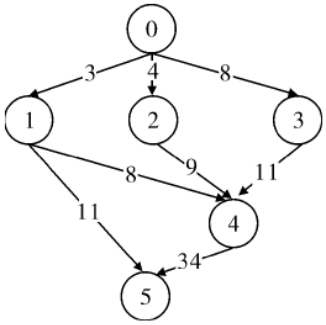
L refers to the m order matrix, element K is the representation of width of the channel in the processing cores.

T={T1，T2，T3……，Tn} represents n task sets, where the elements correspond to a task.

E refers to n order policy, the element e means amount of communication between T tasks. DAG is set to assume the directed set matrix, and e is positive, e is negative output said communication interruption.

C is the product of L and E, which is m*n square matrix, and common representation of the tasks of the flow and processing analysis. C represents the dwell time and the highest computing space of the task at the core.

T and E constitute the main DAG of the task, and usually the task model has only one way entrance node and one way output. As follows:



According to the above can be learned that the communication between the task 0-1 is 3, and the execution of the task processing time will be derived from the matrix analysis. If the DAG task model topology is defined as TSL.

Task scheduling output can be described as:

Schedule(a)=min{Schedule(ai)}

It means the total computation time of the scheduling scheme is equal to the minimum scheduling time of the model budget set, a is an arbitrary scheduling scheme, which represents the least time for consuming solution.

2 .Standard explanation of shuffled frog-leaping algorithm

Usually, the standard shuffled frog leaping algorithm (SFLA)we mentioned refers to good application of swarm intelligence evolutionary algorithm compatibility and flexibility in 2003. Proposed by Eusuff et al., based on the prototype of frog foraging group and foraging subgroup's classification model, and the process of real-time information exchange. Through the algorithm architecture and multi-core processor with transplantation, it can exchange information and task allocation and scheduling problem in well coordinated global search and internal search, which makes the algorithm structure can more quickly get the global optimal solution. The basic algorithm process is as follows:

(1)Global information interaction among multi processors

A. Firstly, the number of the global operation layer and the maximum number of evolution of the sub groups are set up, and the upper limit threshold control system is set to fall into the dead cycle.

B. Set up the initial data for a discrete population and divide the class according to the law of subgroups.

C. Generates the appropriate disposition, and carries out the first priority ranking.

D. Detect the time of the global evolution, if the threshold is reached, then stop, or continue to operation.

E. Finishing the second degree adaptive ordering according to the calculation results, and in accordance with the rotation mode built into subgroups.

F. Perform sub internal search.

G .Merge the same solution subgroups, and return to the global information exchange step.

(2)Analysis of subgroup search

A. Firstly, the operation model is established to calculate the optimal solution and the worst solution of the current subgroup classification, and the corresponding data values are extracted.

B. According to the global exchange order, try to solve the worst solution:

$$F_{\text{update}} = F_{\text{worst}} + \text{rand}() \times (F_{\text{best}} - F_{\text{worst}})$$

C. If the above update solution due to the worst solution, then continue to update, otherwise the use of G instead of F value, from zero to re-operation, if it still can not get the optimal solution, then randomly generated values.

D. If the upper limit of the saturation of the subgroup is reached, then the information will be returned to the whole. Otherwise it continues search in subgroup until data saturation.

In the process of global search, if the adaptive mixed operation system is introduced, it can improve the ability of the algorithm in space deconstruction operation. Combined with the simplified search results which made by previous SFLA algorithm in the field, the swarm intelligence algorithm optimizing calculation of deconstruction, and at the same time, there will be chaos and local optimum values of slow convergence rate inevitably, which is now the main problem of centralized processing.

3 Improved Scheduling based on shuffled frog-leaping algorithm

The only group algorithm space mapping scheme and research base on the results of using binary PSO (binary PSO, BPSO) algorithm, the particle is expressed in a hypercube space mapping, and space moving particles realized by the corresponding {0,1} flip. However, this kind of algorithm does not meet the requirements of the constraint model, and can not accurately describe the coding sequence of the task and the sequence of the characters. Therefore, the analysis based on the discrete swarm intelligence algorithm in order to improve shuffled frog-leaping algorithm.

3.1 Initialization and individual coding

Under the background of heterogeneous multi-core processor, there is a certain constraint relation, which requires multi task scheduling. At the same time, the problem of improving the task set and the speed of completion is solved. When the M processor allocation scheme is analyzed under the n tasks, the individual coding method needs to be able to accurately describe the TSL in a limited storage space. The author found that can be used to deal with the individual task scheduling problem using the following matrix to describe the characteristics:

$$F = \begin{bmatrix} f_{0,1} & \cdots & f_{0,n} \\ f_{1,1} & \cdots & f_{1,n} \end{bmatrix}$$

Each row element in the F matrix represents the TSL value and the task sequence, and the corresponding processor core allocation scheme. The following figure shows the corresponding operating mechanism of the four core processors allocation scheme:

0	2	3	1	4	5
3	2	1	4	2	1

This encoding method can not only describe the core processor space allocation and execution sequence number of each element in the collection of rigorous exactly, with a high degree of non-reproducibility, but also it is easy to reverse decoding encoding program, and get the only positive solution. In addition, the random algorithm is usually adopted to increase the population diversity in the population initialization process of swarm intelligence algorithm. At the same time, in order to enhance the coding optimization ability, but also in order to maximize the algorithm to avoid the problem of early programming holes and the local extremum knot. Therefore, in the process of individual initialization, the data should be evenly distributed throughout the entire super cube search space, and keep the dynamic search's full coverage.

3.2 Update of individual coordinate position

Shuffled frog-leaping algorithm in standard is a continuous search optimization algorithm for the spatial coordinates of the standard algorithm is more simple for the individual in terms of position coordinates, and the approximation algorithm is better, which is similar to the higher mathematics in the continuous function approximation method. But in the swarm intelligence algorithm, operating scheduling with the discrete space, according to the two dimensions including the nuclear number processing and exchange operations, deciding probability and update by positive and negative subgroups. So it needs to separate the discrete algorithm, according to the particle swarm optimization algorithm for global probability approximation.

(1) According to the probability of half of the original location, the sub position of the sub-group is updated or re-carried out and processed to select the coordinates:

$$F_{\text{update}} = \begin{cases} \text{rand}_1() \otimes (\text{rand}_2() \odot (F_i \oplus F_{\text{best}})) & F_i \neq F_{\text{best}} \\ \text{rand}_2() \odot F_i & F_i = F_{\text{best}} \end{cases}$$

(2) According to the definition and type of topological sequence after the update, it will generate a random integer P, which means the optimal solution of P in set of TSL's subgroups, left n-p refers random generation, the combination of the new TSL generated, the value assigned to the subgroup of individuals, but the core number assigned process is not changed becoming topology learning or topology memory.

(3) The subgroup adopts the self update method to select the best individual, and selecting the random integer P, retains the former P bit, and it is as the same as (2), getting the overall optimal condition. Through this program, each subgroup search can take into account the individual coding and processing of nuclear number distribution enhancing the search capability of optimization individual global.

3.3 Adaptation of solution

According to the principle of scheduling and evaluation of the basic multi core program, the

completion time of the worst solution is the evaluation criterion. When the group of the worst solution's completion time approaching the optimal design value, it means the higher of the degree of completion for said scheduling. The whole process follows the individual matrix fitness function, giving a specific coding scheme. In decoding, it only needs to retreat according to topological sequence, and then according to the mantissa line obtained by the decomposition of m's execution sequence which can be the perfect realization of data reduction and core scheduling.

Fitness formula: $f = \max\{lt(P_i)\} \qquad j = 1, 2, \cdots, m$

$$lt(P_j) = \max\{lp(T_i^j)\} \qquad i = 1, 2, \cdots, n$$

$$f = \max\{lp(T_i)\} \qquad i = 1, 2, \cdots, n$$

3.4 Flow and optimization of algorithm

Heterogeneous multi-core processing computing based on Shuffled frog-leaping algorithm where SFLA system itself in the process of global iteration, will get better in a certain number of times after the value of the corresponding search success rate will decline. Now it is easy to appear in the case about sub-group search stop and local difference highlights, the optimal value of addressing is blocked. Therefore, it needs to take multi optimization. Cross learning algorithm is introduced into similar GA, global iterative process, the number of iterations for 50% individual subgroups of optimal stochastic probability learning to produce new mop, effectively reduce the influence of individual difference. On the other hand, through the poor group on individual, taking tolerant scheme, namely in the iterative rounds of subgroup with update to replace the worst individual influence gradually, so as to reduce the difference.

CONCLUSION

Through the above improvement measures, it can make the SFLA to avoid the difference of the algorithm in the later period of the algorithm. To improve the ability of individual search and space position search, the overall convergence speed of the algorithm is improved. The improved heterogeneous multi-core processing based on shuffled frog-leaping algorithm makes sure that the search process has been optimized, the optimal solution can enhance the efficiency which has very good value of application and research.

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