Research on softman Cooperation Mechanism and Algorithms¹

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Abstract: Based on contract net model and acquaintance model for softman cooperation, a new model which based on the acquaintance coalition and softman's service centre is proposed. According to the acquaintance decision-making function and service center decision-making function, an effective collaboration softman can be quickly accessed. At the same time , using the two update strategies of acquaintance and service centre, the softman's mind parameters can reflect changes in the environment. The new model make it more efficiency in searching cooperator and more reliable in cooperation process.

Key words: Softman; contract net protocol; acquaintance model; task cooperation

I. INTRODUCTION

Softman is a sort of Software Artificial Life with human-intimated intelligence and ability to live on computer network. That is to say, it is a kind of "virtual robots"[1][2][3]. A single softman's ability is limited, so he often faces tasks that he can not finish only by himself. In this situation, a number of softmen's cooperation will be needed[3].

At present, the research on distribution model of softman system cooperation method is mainly divided into two types: contract net cooperation method and acquaintance cooperation method:

(1) Contract net cooperation method

Document[4] proposes a contract net protocol: when a softman needs to determine a cooperator, firstly he will broadcast the task tender to all of the softmen in the system. On receipt of the task tender, the softmen will make assessment according to their own resources and abilities, and decide whether they tender or not. if they decide to tender, they need to send their bids to the sender and the sender will evaluate all of the bids he collected and determine the most suitable cooperator. As the contract net protocol needs broadcasting tenders to all of the softmen in the system, communication abilities and resources of the system are put high demands.

Centralized coordination support is a common way to reduce the system's communication costs .This way is to set up a special center coordinating softman to take charge of saving and coordinating all the other softmen's information[5]. In application of this method are Lashkari cooperation framework[6],and Genesereth and Ketchpel[7] alliance systems. The former uses the bulletin board softman, while the latter uses the Communication service softman, to function as the center coordinating softman. Centralized coordination support lowers the cost of communication, but still requires a large amount of communication expenses to ask center coordinating softman for search of cooperating softmen[8].

(2) Acquaintance model cooperating method

Roda and Jennings, etc., put forward an acquaintance model[9][10][11] to get access to the basic information of cooperating softmen. In this architecture, they design a "model of self" to indicate the information of softman himself and a "model of acquaintance" to indicate the information of other softmen in terms of resources and capacities .If he needs to determine a cooperating softman, he will first of all assess the abilities of his acquaintances, and then choose the most suitable cooperator. This approach reduces the cost of system's communication. Through the acquaintance model, other softmen's information can be accessed, but the acquaintance's information is fixed and can not timely reflect the current state of each softman in the system. Besides, the acquaintance' ability will directly have an impact on the softman.

Through the above analysis, we can conclude that the contract net model is a kind of approximately global optimum allocation method, while the acquaintance model is a local optimum allocation approach. This paper, for the limitation of the above two models, proposes a softman cooperating model which is based on acquaintance collection and service-center. This model solves the problems of cooperator-searching

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efficiency, as well as the reliability of cooperators. This model is improved in the following aspects:

(1) An acquaintance collection is added to the softman system. Through the acquaintance decision making function, the cooperator is determined. As in the softman system, the cost of communication is much larger than the cost of calculating. Through the introduction of acquaintance collection, the cost of system' communication is reduced, and then the price of looking for cooperators is also lowered.

(2) An service center softman is added to the softman system, who is to maintain the snapshots of softmen with collaborating abilities in the system. When softman can not find a suitable cooperator in the acquaintance collection, he can look for his cooperator in the service center according to talent service center decision-making function. The introduction of service center increases the solution space for softman to look for his cooperator, and avoids the problem that, in the process of cooperation, softman can only search for local solutions in the acquaintance collection.

(3) It defines a acquaintance collection updating strategy, which makes the acquaintance collection of softman system reflect the current state of the system, strengthens the adaptive capability of softman system, and increases the reliability that the cooperator can be found.

II. COOPERATION MODEL STRUCTURE

According to the characteristics of contract net model and acquaintance model, this article builds a hybrid model structure, based on acquaintance collection and talent service center. The model structure diagram is as follows:



Fig.1. Cooperation model based on the acquaintance collection and service center

According to the different roles in the system, softmen can be divided into two types:

(1) service center softman: Service Center softman is a special kind of softman. It is the intermediary of softman system, responsible for keeping the softman name list who is willing to cooperate. The softman with cooperative wish voluntarily registers at the service center, and the service center records the softman's mailing address, ability description keywords. At the same time, the service center is also responsible for maintaining the evaluation information made by the system to this softman.

Service center softman, indicated with SMS, can be formulated as:

 $SMS = \{ < SM_k, SMB_k, SC_k > | k = 1, 2, ..., m \}$

Of which, m says the number of softmen in the service center, SM_K says the mailing address of the No.K softman. SMB_K says the ability vector of the No.K softman. SC_K says the evaluation level of the No.K softman.

(2) Implementary softman: the implementary softman , the core of the system, is responsible for the realization of specific issues. He receives tasks from the user or other softmen, and then makes different decisions according to different tasks:

a) If $SMB_k \ge TB_i$, the implementary softman will treat the task separately.

b) If $SMB_k < TB_i$, that is ,for the tasks that the softman can not finish alone, he will firstly sub-divide the tasks into a series of tasks, and then search for cooperators to do it together. Meanwhile, he will also be in charge of unified planning and coordination of the cooperators.

III. THE SOFTMAN'S COOPERATING

PROCESS

By means of acquaintance collection and service center softman, this article improves the classic contract net cooperating process^{[4][12][13]}. When the softman invites bids, in accordance with the acquaintance collection decision-making function and the talent service center decision-making function, the bidders could either come from acquaintance collection or service center .Meanwhile, by means of its updating strategy, the softman acquaintance collection could timely reflect the changes of environment.

1. Acquaintance collection decision-making function

After receiving the task Ti, softman SM_k needs to select a suitable acquaintance to cooperate through an

acquaintance evaluation. The acquaintance could be screened with two indicators: the first is the acquaintance's implementary capability SMBj; the second is the acquaintance's credibility Trust (SMk, SMj).The following decision-making function is introduced:

FS(SMk,Ti)={SMj|SMBj>=TBi,

Trust(SMk,SMj)>=TH(SMk,SMj),j=0,1,2...,M} (1) Of which, M says the number of acquaintances.

2. Acquaintance collection's decision-making function: Remove and fill

(1) filling operation (fill) :

In an acquaintance collection, when the number of acquaintances is smaller than the size of sliding window, the softman will operate to fill . The filling operation is shown as follows:

while(sizeof(Friend(SM_K))<sizoef(FW(SW_j))
{

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\begin{array}{l} SM = fetchCooperator(SMS) \\ add(SM_K, SM_j) \end{array}
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}
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(2) Removing operation(remove):

When the number of acquaintances is larger than the size of sliding window, or when the credibility of acquaintances is smaller than the number ξ , a removing operation is needed now. The pseudo-code of removing operation is indicated as follows: if(sizeof(Friend(SM_K))<sizoef(FW(SMj))

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 \begin{cases} sortFriendByTrust(Friend(SM_K)) \\ SM=fetchLastFriend(SM_K) \\ remove(SM) \\ \}else \\ if(Trust(SM_K, SM_j) < \xi \\ \\ \\ remove(SM) \\ \} \end{cases}
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3. Service center decision-making function

When softman SMk chooses his cooperator in the service center to fulfill task Ti, he will screen the cooperators mainly by two indicators: the first is the acquaintance's implementary capability SMBj ;the second is the acquaintance's credibility Trust (SMk, SMj).The following decision-making function is introduced:

 $S(SMk,Ti) = {SMj|SMBj \times SMEj = TBi,$

 $SMEj \ge THE, j=0,1,...,M$ (2)

Of which, M says the number of registered softmen in the service center.

4. Bid-winning decision-making function

The traditional bid-winning decision-making function adopts different strategies for problems of different areas. More representative are the weighted average method, the maximum / minimum, the maximum density (dichotomy), etc.

This paper, combined with the above-mentioned softman trust parameters, introduces the following task decision-making function :

 $V(SMk,Ti)' = V(SMk,Ti) \times Trust(SMk)$ (3)

Of which, V (SMk, Ti) says the returned bid value by bidders. Trust equals to discount rate given by bidders. The higher the trust is, the less discount of bid value the bidders offer.

IV. EXPERIMENTAL DESIGN AND THE RESULTS

This article will use the experimental design and data analysis to clarify that ,in the softman system, the introduction of acquaintance collection and talent service center will have influence on the softman collaboration. The experiment is made on the platform^[14] JADE (Java Agent Development Framework). We have materialized two different softman cooperating processes on this platform.

In order to simplize the model analysis, the softman's ability is indicated with two-dimensional vector as: SMB (HZ, QS), of which, HZ says the softman's calculating speed.QS says the size of available mission queue in the softman.

In the experiment, there are 6 mission executives, one mission manager. The mission executives are of the selfish type. Their probability of mission success are 1.0,0.8,0.6,0.4,0.2,0. Experimental data are shown in Figure 2 and Figure 3:



Fig 2. Cooperating mission -time diagram



Fig 3. Cooperating mission-cost diagram

In Figure 2, due to the softman's selfishness, the number of negotiation failure ,which is based on the contract net cooperation model, increases evidently. It leads to an increase of mission implementing time. The improved cooperation model, through the updated strategies of acquaintance collection credibility and talent service center, makes the selected cooperators have high success rate of implementation. Especially when the number of mission increases and acquaintance collection stablizes, the mission implementing time will reduce significantly. In Figure 3, with the mission number increasing, the improved cooperating method costs far less than the traditional contract net cooperating method.

V. CONCLUSION

A softman cooperating method is proposed in this paper, which is based on an acquaintance collection and service center, and solves the problems of cooperatorsearching efficiency and the credibility of cooperators in the process of cooperation. The softman uses acquaintances collection and service center, according to acquaintance decision-making function, to quickly have access to the softman who can supply effective cooperation. At the same time, by means of acquaintance updating strategies, softman system could timely reflect the changes of system environment. The result shows that the softman cooperating method, could significantly improve the cooperating efficiency of softman.

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