The Collaborative Search with Shared Cognitive Space

Tokujiro Kizaki

School of Information Science,
Japan Advanced Institute of Science and Technology

February 15, 2002

Keywords: shared cognitive space, collaboration, real-time search, multi-agent, emergency.

In this paper, we investigate collaborative search processes. We controll the degree of cognitive space : (a) the experimental space was only shared, and (b) the experimental space and the hypothesis spase were shared. We compare the performance of searching goal in the two types of collaboration adove with the performance in the case of two agents independently searching goal. If the performance in the former cases exceeds that in the latter case, we approve of emergence brought by interaction by the two agents. The results of the computer simulations are consistent with our ordinary knowledge on collaboration.

Recently, we often forcus collaboration. The collaboration means joint research and collaborating work. How much actual effect have these collaboration? Do not do the collaboration thoughtlessly,because it does even the failure although it does even the success. However, the need of such collaboration is increasing from now on. And it is an important problem to clarify such a guideline that designs effective collaboration.

The range regarded as the object of the collaboration is various and be difficult to discuss the effect of the collaboration to all the objects. We think the maze search that hypothesized that the robot of the real world searches the fundamental search problem in the real world in this paper. We think the search that used the robot to the such search problem that is represented to the maze. 1 agent search is demands huge time, when the search space is big. Therefore it is conceivable to do the cooperation search that used the plural unit. However, there is the problem that the communication cost increases to use many number of agents needlessly. And there is the problem that such a cost that prepares many robots increase. We think that a few agents does the collaborative search effectively in this paper.

It is known that there is a difference by the cognitive space where the agent shares in the collaborative search of a plural agents. The cognitive space is the recognition that is possible information space of an agent. For example, it is the space where the agent can acknowledge when the agent has the vision. Which cognitive space the designer causes shared how becomes such a big factor that causes the collaborative search succeeded. The collaboration research that used the multiple agent after the 90's has been carried out. There is the method that uses the sharing of the cognitive space as the method of the collaboration. 2-4-6 task problems and two cards game problems are solved as the research intended for collaboration in a comparatively high level. In those research, they establish several levels to the collaboration and be examining the difference of the effect. With the paper, they are saying that the level of the collaboration is the difference of cognitive space. They divide the shared cognitive space and be inspecting the effect empirically.

In this paper, we think two collaborative levels that is the experimental space was only shared, and the experimental space and the hypothesisspase were shared, when we use the concept of the shared cognitive space to the maze problem. After we define each levels clearly, we examine how the effect of the sharing of the cognitive space fluctuates by the computer simulation empirically. We use Multi-Agent Real-Time A* (MARTA*) as the search scheme of the maze search. And we modify Real-Time A* that is used to MARTA* by using the above shared cognitive space.

The guideline that measures the effect of each collaborative levels is necessary to think them. The concept emergency is defined in this paper for that. We compare the search results of the collaborative condition and independence condition. At this time, the number of the agent of the collaborative condition and independence condition are same. And there is the gain that the search result in the collaborative condition consists better than the search result in the independence condition. With this paper, we define the gain like that as emergency and then inspect the efficacy of the collaboration empirically.

On the basis of these models, we examine such a condition that the search by a few agent effectively. For that, we construct the model of the search process to the computer, and examined empirically by the computer simulation. The experiment results showed that there is the collaborative design that used the shared cognitive space as the method that does the collaborative search to the such search problem that is represented to the maze.

The case result of the experimental space was only shared showed that emergency appears even if it does not have the communication function just keeping the note function to the experimental space for the agent. And the agent holds the estimation cost that is renewed for the setting that does not use the communication devices independently. Therefore, the problem of the overestimation of the criticism worth that the MARTA* holds does not break out. It showed the possibility regarding the improvement of MARTA*. Next, even in the case that the experimental space and the hypothesis space were shared emergency appears. However, the search results showed that the sharing of the more new price of the estimation cost does not become to the big factor that helps the search. When we think about overestimation of the more new price of the estimation cost and information exchange of the estimation cost, such shared cognitive space where shares

the estimation cost is not necessary. It is the same conclusion even if we think communication cost of each time and construction cost of the communication system. However, in the case that it is establishing the subgoal with the plan change the information exchange is only when the plan is changed. In this case, the experimental space and the hypothesis space were shared obtains a bigger collaborative effect than the experimental space was only shared.

There is an appropriate level according to the problem in the collaborative level and we shall be necessary to set up the level appropriately according to those is concluded through these experiments.