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Scout of the Route of Entry into the Enemy Camp in StarCraft with Potential Field

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***Abstract*— In StarCraft, a popular RTS game, reconnaissance of the enemy camp is essential in order to anticipate the tactics and strategies of the enemy. However, if enemy forces are located in the shortest path to its camp, it is not possible for scouts to reach its enemy camp by using a standard shortest pathfinder. In this paper, we propose a method for controlling scouts using potential fields, which improves the possibility that our scouts discover a penetration route to the enemy camp.**

Keywords—potential field; RTS; StarCraft; scout;

I. Introduction

Our laboratory has participated in game AI competitions using a PC game called StarCraft since last year and has won The Mixed Division of Student StarCraft AI Tournament 2012[1]. Prediction of the enemy strategies is important in order to win over other participating AI teams. It is therefore necessary to collect information on the enemies. However, if the terrain is complex, it becomes difficult to break into the enemy camp because it is unlikely that a scout in a selected a route will not encounter its enemy forces.

In StarCraft, it is possible to obtain only the information on an enemy within the field of view of the friendly soldiers. If the enemy is out of the sight, such information is not updated. Therefore, in order to collect information of the enemy, friendly soldiers must penetrate into the center of the enemy side. For a basic AI in StarCraft, if one specifies the coordinates of the destination, their soldiers will move following the shortest path from their terrain. Therefore, if enemy forces are located in the middle of the shortest path, it is not possible to break into the enemy camp.

In this work, we attempt to resolve this issue by using potential fields. Potential field is a concept that has been used for robot movement control. The purpose of our work is to find a path that could lead a scout unit to successfully penetrate the enemy camp without any contact with enemy forces.

Previous work [1, 2] exists which also considers reconnaissance in StarCraft. Techniques used in their papers are intended to control a scout unit using vector movement and potential flows, respectively, *after* entering the enemy camp. On the contrary, our work is intended to control a scout unit based on potential field movement *before* entering the enemy camp.

II. Potential Field Route Scout

A. Potential Field

A common potential field method generates an attractive potential for the destination and a repulsive potential for an obstruction. It is therefore possible to reach the destination while avoiding obstacles. However, it is known to easily fall into a local optimum if there are many obstacles. Therefore, we need to modify such a method for our problem.

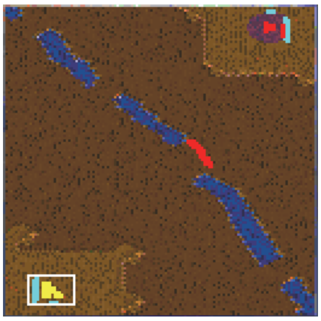
B. Potential Field Route Scout

First, we define eight coordinates around the current position of the scout unit and calculate the distance to a target, final destination or obstacle, from each coordinate. We then calculate the potential value of each of the eight coordinates according to the distance to each target. We next move the scout unit to the coordinate with the highest potential value. If multiple coordinates have the same potential value, we give the higher priority to the coordinate with earlier calculation of potential values. Let P_i be the potential of coordinate i, F_t the potential function due to the t th target out of n targets, d_{it} the distance between coordinate i and target t. The potential value at coordinate i or P_i can be given by

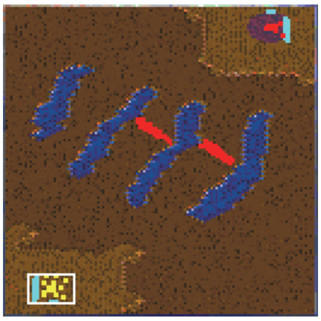
$$P_i = \sum_{t=1}^{n} F_t(d_{it})$$

Recall that the purpose of this work is to make sure the reconnaissance soldier (scout unit) gets to the heart of the enemy camp. Therefore, we also set an attractive potential at the center of the enemy camp. A repulsive potential is also set for each of the enemy forces or immovable terrain. Because the information on the enemy forces out of sight cannot be collected, we generate a repulsive force to each position where our scout was previously destroyed. This completes our basic potential field setting. However, since the possibility of falling

[1] http://www.sscaitournament.com/index.php?action=2012



MAP 1



MAP 2

MAP 3

Figure 1 Three maps in our experiments

into a local optimum is high, we describe below our modifications to this basic setting.

First, we generate a repulsive force to the coordinate the reconnaissance soldier was just present. Because of this repulsive force, it is possible to prevent the scout unit from performing meaningless reciprocating.

In addition, potential field calculation is performed only when our scout unit arrives at the coordinates specified previously: the one with the highest potential value. If this is done with a less interval, the scout unit might have less chance to escape from its local optimum, getting stuck in the current position.

III. Experiment

We conducted performance comparisons with three maps shown in Fig.1. In each map, our camp is located in the lower left corner of the map, while the enemy camp is located in the upper right corner. There are three entrances to the enemy camp. Enemy forces are placed along the shortest path to its camp. 10 scouts are initially placed in our camp.

We only send one scout at a time to the enemy camp. If this scout is destroyed by enemy forces, we send another scout. When a scout can invade the enemy camp, we consider that our reconnaissance mission is successful, record the number of our lost scouts and also the elapse time. If all scouts were destroyed, this reconnaissance is considered failed. Similarly, if the elapse time exceeds 10 minutes, this trial is also considered failed. We ran 100 trials for each map. In Map 1, there exist four bridges, where the central bridge is blocked by enemy forces. In Map 2, five narrow roads exist, where two roads in the center are blocked. Map 3 represents a terrain consisting of more than one islands connected by bridges, where enemy forces block some bridges and one entrance to its camp.

Table 1 shows the experimental results. In fact, we also ran BTHAI[2] introduced in the paper of Hagelbäck [3] which also uses potential fields for reconnaissance. However, BTHAI did not succeed at all in penetrating to its enemy camp in all maps. We therefore omit its results in Table 1.

TABLE I. EXPERIMENTAL RESULTS

	MAP 1	MAP 2	MAP 3
Success rate	***100%***	***96%***	***56%***
Lost average	***1.13***	***2.15***	***5.87***
Time average	***111sec***	***203sec***	***391sec***

From Table 1, it can be seen that the proposed method shows a promising performance in simple maps: Map 1 and Map 2. However, its success rate is lower in more complex Map 3. For this map, we have observed our scout units reciprocate the same long route. The cause of this phenomenon is that the repulsive force at the previous coordinate of reconnaissance soldier disappeared in a short time. How to resolve this issue is left as one of our future work.

IV. Conclusion

Reconnaissance of entry route to the enemy camp using potential fields has a promising performance above a certain level. However, our scout units may fall into a local optimum in more complex maps. In addition, enemy forces used in this work do not dynamically move, but actual enemy forces move as time passes. As a result, we plan to resolve these issues in our future work.

References

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[2] Kien Nguyen, Zhe Wang and Ruck Thawonmas, "Potential Flows for Controlling Scout Units in StarCraft," Proc. of the 2013 IEEE Conference on Computational Intelligence and Games (CIG), pp. 344-350, 11-13 Aug. 2013.

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[2] http://code.google.com/p/bthai/