Demonstration of Multi-agent Potential Fields in Real-time Strategy Games

(Demo Paper)

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ABSTRACT

Bots for Real Time Strategy (RTS) games provide a rich challenge to implement. A bot controls a number of units that may have to navigate in a partially unknown environment, while at the same time search for enemies and coordinate attacks to fight them down. Potential fields is a technique originating from the area of robotics where it is used in controlling the navigation of robots in dynamic environments. Although attempts have been made to transfer the technology to the gaming sector, assumed problems with efficiency and high costs for implementation have made the industry reluctant to adopt it. Our demo shows the use of Multi-agent Potential Fields (MAPF) in an open source RTS game. We will demonstrate both the potential fields as such, and the coordination of the agents.

Categories and Subject Descriptors

I.2.11 [**Computing Methodologies**]: Artificial Intelligence, Distributed Artificial Intelligence - *Multi-agent systems* and I.2.1 [**Computing Methodologies**]: Artificial Intelligence, Applications and Expert Systems - *Games*

General Terms

Algorithms, Design, Performance

Keywords

Artificial Potential Fields, RTS Games, ORTS, Multi-agent Bot

1. THE ORTS ENVIRONMENT

Open Real Time Strategy (ORTS) [1] is a real-time strategy game engine developed as a tool for researchers within artificial intelligence (AI) in general and game AI in particular see Figure 1. ORTS uses a client-server architecture with a game server and players connected as clients. Each timeframe clients receive a data structure from the server containing the current game state. Clients can then issue commands for their units. Commands can be like move unit A to (x, y) or attack opponent unit X with unit A. All client commands are executed in random order by the server.

2. THE USED TECHNOLOGY

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Figure 1: The 3D view of the ORTS Tankbattle game.

In 1985 Ossama Khatib introduced a new concept while he was looking for a real-time obstacle avoidance approach for manipulators and mobile robots. The technique which he called *Artificial Potential Fields* moves a manipulator in a field of forces. The position to be reached is an attractive pole for the end effector (e.g. a robot) and obstacles are repulsive surfaces for the manipulator [3].

Although being a well-known technology in robotics, potential fields has not gained very much interest in the game industry. We show that, not only is it an efficient and robust solution for navigation of a single unit, it is also an approach that works very well in distributed settings of multiple agents. Figure 2 shows the potential fields for the green team.

3. THE INVOLVED MULTI-AGENT TECHNIQUES

There are several issues to be addressed in a RTS. First, all units are moving in parallel, which means that they will have to coordinate their movement in some way without bumping into each other, or the surrounding environment. We use potential fields similar to the ones used by e.g. Mamei and Zambonelli [4] to let the units keep themselves at the right distance.

Second, to improve the efficiency, we coordinate their attacks through the use of a central military commander. This agent is not embodied in the field, but makes sure that no extra shots are

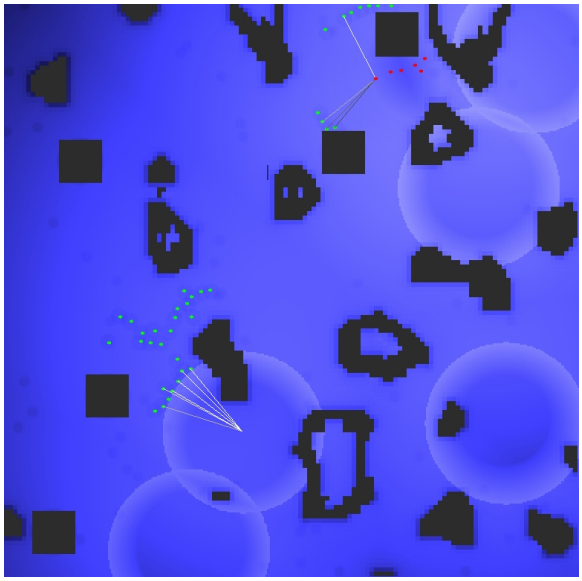

Figure 2: The potential field generated by the units and the terrain. The white lines illustrate the coordinated attacks on a base (lower left) and a unit (upper right).

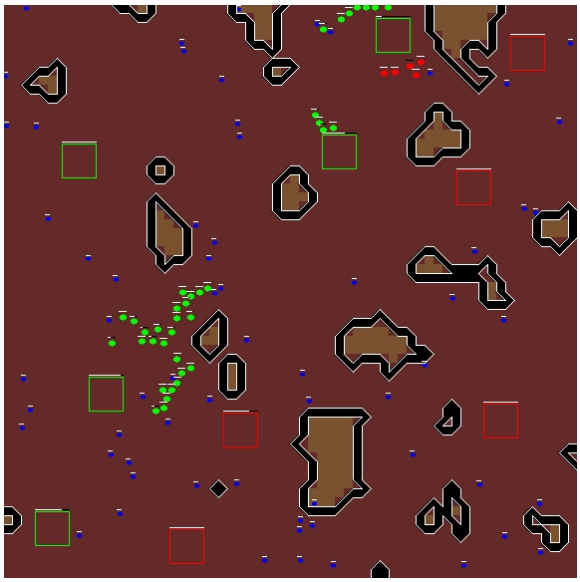

Figure 3: The 2D view of the same ORTS Tankbattle game.

spent on opponent units that are already under lethal attack. This is important, since there is a cool-down period during which the units can not attack after a shot.

Third, the commander chooses what opponent to attack first. This is a strategic decision that may follow several strategies, e.g. to try to split the enemies in more, but weaker groups, or try to attack the enemy from the sides. In order to make the right decision, an analysis of the spatial (and health-related) positions of the opponent agents is needed.

4. THE INNOVATION OF THE SYSTEM

The use of *separate potential fields* for the control of tactical, navigational, and strategic matters in a system of multiple units (our agents) in a RTS game has, as far as we know, not been described in academia before. Traditionally, A* and different types of state machines has been state-of-the-art in the gaming industry. Lately we have seen a growing interest for alternative solutions, partly as a result of the customer demand for more believable computer opponents, partly as a result of the increase in processing power that third generation game consoles such as Sony PlayStation 3 bring us. We believe that the use of both MAS techniques and potential fields (and why not our proposed combination of the two?) will gain ground as the game AI field matures. Lately, the performance of our solution has increased significantly compared to the results presented in the main paper [2] and these late breaking improvements will of course be demonstrated.

5. THE INTERACTIVE ASPECTS

Unfortunately, the human player interface is not yet released by the ORTS developers. If it will be available at the time of the conference, we will also be able to offer the audience to play games against our MAPF based bot. If not, we will illustrate its features through games against other computer opponents. We will be glad to illustrate the performance of our recently updated solution against the winner of the ORTS tournament described in [2].

There will be two windows updated in real time. The main window shows a 3D (see Figure 1), or 2D (see Figure 3) view of the units and the terrain. The second window (see Figure 2) shows the potential fields of a certain unit, as well as the resulting coordination done by the military commander. The whole potential field is shown here, although in the real application, only the potentials of the positions in the map that are considered interesting are calculated.

6. CONCLUSIONS

We will show a demonstration of a highly competitive game AI bot for the ORTS environment. It is built using the methodology described in [2] and use a combination of Multi-agent coordination techniques and potential fields to try to win its games.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

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