RoboCup Rescue 2016 – Rescue Simulation League Team Description
MRL (Iran)

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Abstract. In this paper we will describe the preparations we have made to take part in RoboCup 2016. In this competition we are still using K-means and convex-hull and Hungarian algorithm for map clustering and agent optimization allocation to partitions. These methods granted proportional agents distribution around the map without passing long distances around the map. For searching, we use maximal covering location problem. We also made some changes on ambulance decision making to have better estimation in time to death calculation and number of needed ambulances to rescue a civilian. For police agents we are utilizing a drainage basin model to create quick access paths from all partitions to a recently discovered fire site.

Keywords: RoboCup, Rescue Simulation, K-means, Hungarian, Set Covering

1 Introduction

In 2012[1], 2013[2] and 2014[3] we used several different algorithms for allocating ambulance agents to their goals. Some of mentioned algorithms are: Market Base Algorithm [4] used in 2012, Q-Learning [5] used in 2013 and finally we used Learning Automata [6] in 2014. The performance of these algorithms has improved over time. In 2015, like previous years, we use K-Means algorithm [7] for clustering and partitioning the map, and Hungarian algorithm [8] to assign agents to partitions, Learning Automata [9] for decision making and determining the number of needed agents for a buried civilian. K-Means and Hungarian algorithms granted an optimal distribution for all the agents. These algorithms also minimize the total distance travelled for all agents to reach their assigned partition. In 2016 we have added a new semi-potential field approach so that the ambulances tend to rescue very close and accessible civilians on the way to get to their assigned partition, we have named it "Sticky Move". This had a very good impact on overall number of rescued civilians.

Our massaging system is based on our work in previous years. After some changes that have been done in 2013 on messaging system functionality, we have gained decreased massage size and improved efficiency. In 2014 our focus was on improving efficiency and some changes to improve bandwidth utilization. For 2015 and 2016 competition we did not apply fundamental changes on messaging system and just focused on utilizing the module and better message types for agents.

We have applied some improvement in fire brigade's decision making algorithm. We are still using "Maximal Covering Location Problem" model to improve searching efficiency and minimize agents' traverse. This enables fire brigades to stand in an area and extinguish more building in less time rather than keep moving to extinguish different buildings.

In past years, new clear method was introduced for police agents. The method allowed the police agents to remove blockades much faster, but there are some drawbacks to it. For example in some cases it creates dentate blockades, as a result other agents might get trapped inside the blockade. We have tried to overcome this issue with clearing the roads in a way that makes no trap. And finally we have added a new strategy to police agents which makes them more responsive to scenarios involving huge amount of blockade and remote fires, by clearing a path from the center of every police agent assigned partition to the center of a neighbor partition that is closer to the fire site. It mimics a *drainage basin* that forms a river. In this paper we are going to describe aforementioned algorithms.

2 Ambulance

The main task of an ambulance agent is to maximize the total number of living civilians by the end of the simulation. Our base strategy is that after dividing the map, proportional to number of available agents in the scenario, and creating partitions we assign each agent to a partition and let the agents to search and rescue in their partitions. But sometimes despite the fact that our assignment is very efficient, the agents have to travel a long way to get to their partition (Figure.1), which reduces their utilization factor and efficiency. To avoid this we have added a new strategy called “Sticky Move” which is simply based on potential field motion planning (Figure.2). If an agent detects a civilian closer than a specific threshold to the path (illustrated by green circle) towards the target partition, the agent tries to rescue the civilian before heading towards the target partition. However doing this sometimes will result in too many ambulances trying to rescue the same civilian; to avoid such conditions we are utilizing an algorithm based on Monte Carlo method [10] to estimate the remaining time until a civilian dies and therefore calculate the optimum number of ambulances needed to rescue that civilian, then we assign only as many as needed ambulances to rescue task and let the rest to go and reach their target partition.

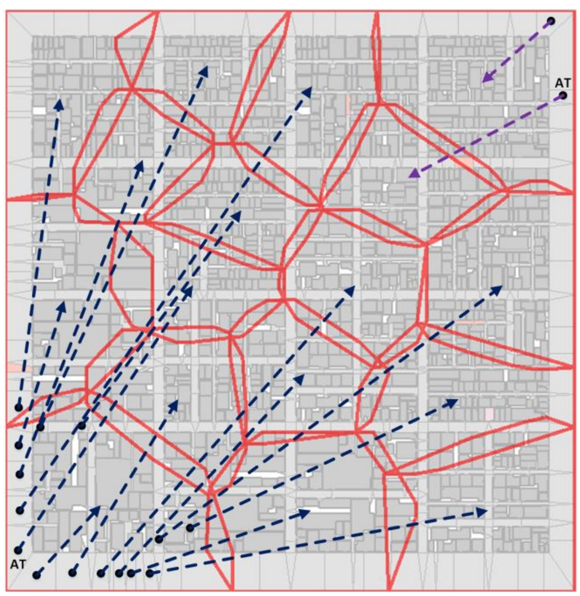

Figure 1. Aggregation of agents in specific zones forces them to travel a long way to get to their partition

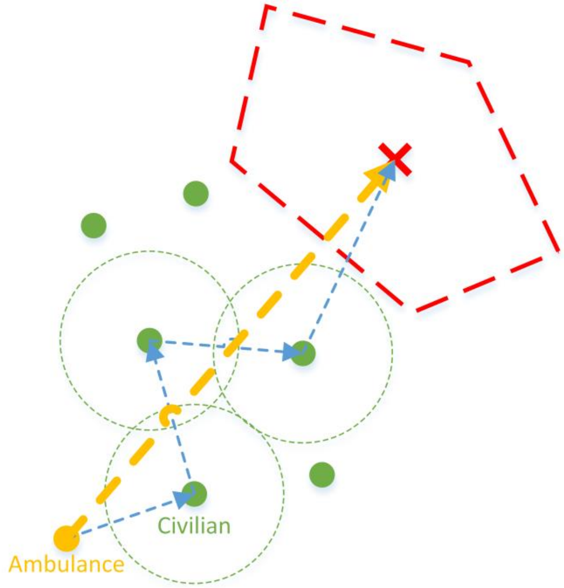

Figure 2. Sticky Movement of ambulance from the starting point (yellow circle) to the center of target partition (red cross). The green dashed circle shows the threshold of civilians' gravitational pull. The ambulance only rescues the civilians that their gravitational pull crosses its main course.

3 Fire Brigade

For situations involving fire it is necessary to act as quick as possible without wasting time on redundant moves. By studying previous results we have found out that we have lots of redundant moves to find a good place to put the fires off, so we decided to use Maximal Covering[11,12] to find best positions on the map for fire brigade agents to stand and put the fires off with minimum movement.

To see how it works, you can refer to figure 3. In this figure you can see three fire points with their corresponding possible positions (colored areas) to put each of them off. Consider how many places can be selected and how many moves can be done to put these fires off.

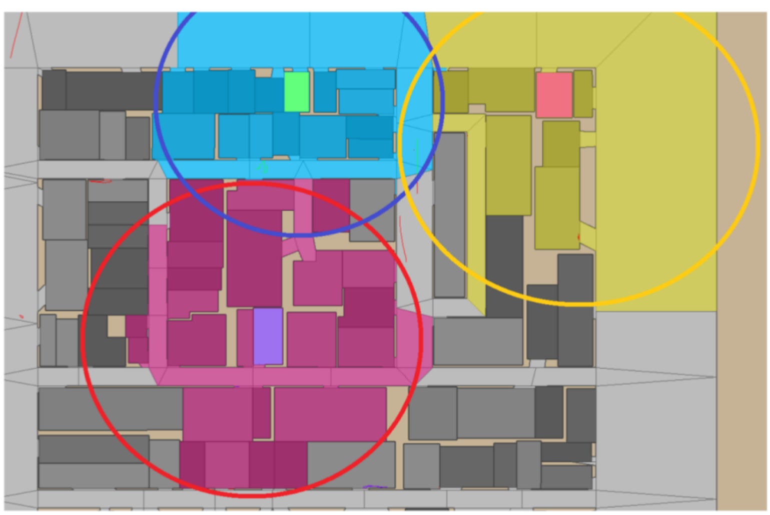

Figure 3. Fire points in three different positions

Solving Maximal Covering problem for these three points helps agents to find a few places that are best to put the fires off with least moves. Figure 4 shows the result of solving Maximal Covering problem for those three mentioned points. At first glance it looks relatively simple to solve this problem but it is actually associated with NP-hard problems and for cases involving many entities it becomes very complex.

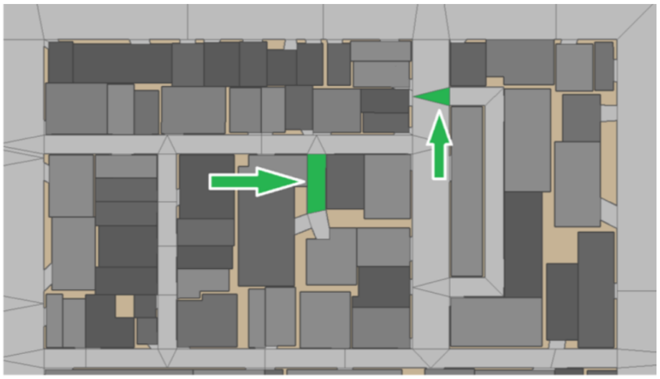

Figure 4. Found point after solving Maximal Covering

4 Police force

Since police agents have direct impact on the other agent's performance, for RoboCup 2016 most of MRL attention was on police agent's coordination and cooperation with other agents. One of the problems we were facing as a result of using new clear method was about dentate blockades that trap agents (Figure 5). It's clear that this problem reduce the agent's performance drastically.

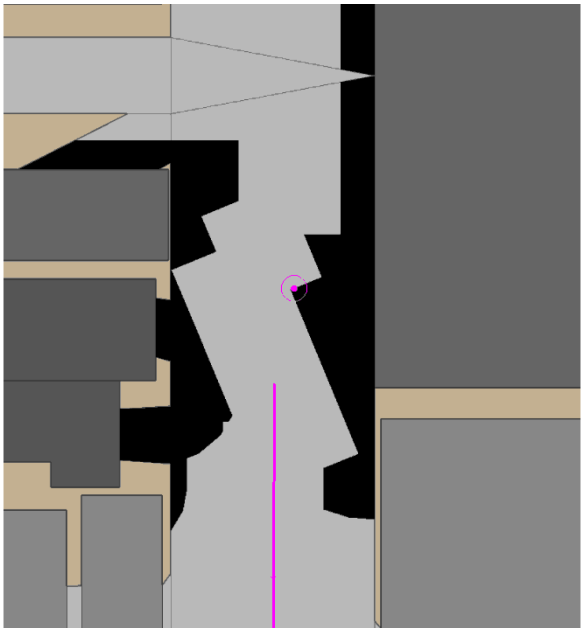

Figure 5. An agent caught up in fragments of blockage

In RoboCup 2014, we used Guideline strategy to overcome this issue. In this strategy, a police agent clears the roads along the guidelines to smoothly clear the road without any residues so that the agents can move along faster, without getting stuck.

Another improvement is prioritization of police clear task based on traffic, importance of the buildings and importance of the partition. Changing priorities improved police and other agent's performance. We have also changed our strategy to unlock trapped agents with higher priority.

For RoboCup 2016 we have added a new strategy based on drainage basin that forms rivers to deliver a quick access to a newly discovered fire site. In this strategy each police tries to open a path from the center of its assigned partition to the center of a neighbor partition that has a shortest distance based on A* to the discovered fire site, as a result there will be at least one path from each partition to the fire site, for fire brigades to access the burning area and put the fire off faster. Figure 6 shows the details.

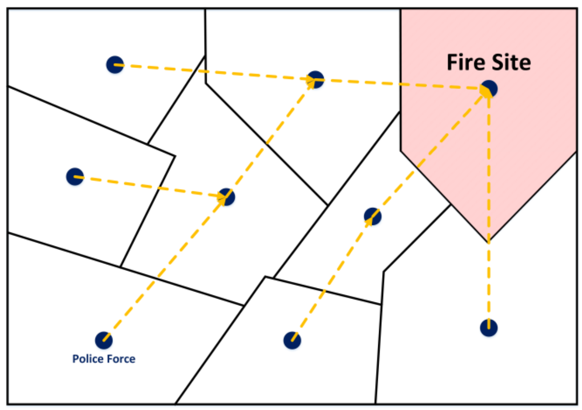

Figure 6. A tree structure formed from drainage basin behavior of the agents, trying to clear a path from center of their assigned partition to the center of the fire site.

5 References

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