Multi Agent Cooperative & Intelligent Search in Saviour Team

Eslam Nazemi[1], Mohammad Jafar Tarokh[2], Mohammad Ali Fardad[1],
Mohammad Mehdi Saboorian[1], Samaneh Navabpour[1], and Elmira Amrollah[1]

[1] Department of Computer Engineering,
Shahid Beheshti University (SBU), Tehran, Iran
`nazemi@cc.sbu.ac.ir`
`{fardad_m, saboorian_m, navabpour_s,`
`amrollah_e}@ecef.sbu.ac.ir`
`http://www.sbcee.net`
[2] Department of industrial Engineering,
Khadjeh Nasir-Al-Din Toosi University of Technology
`tarokh@cc.sbu.ac.ir`

Abstract. This paper describes the ideas used in designing a multi-agent system. In order to make the agents transmission easier, at first by using the ACS[1][2] algorithm we find the shortest route between the important nodes of the city and clear it. Also another algorithm has been used for the ambulance agents by which they guess the location of the civilians and search for them. Therefore they will have more luck finding and rescuing them. Ambulance team agents and police force agents have been trained previously with the Extended Q-learning and Q-Learning method to make the best decision.

1 Introduction

In present time, with the incoming of hi-tech communication services, the moral communication between human beings for survival takes a new step to a whole new world. By this means, RoboCup Rescue[6] - which is a branch of RoboCup -stepped into the world.

In general we have three types of agents:

- Police Force Agent
- Fire Brigade Agent
- Ambulance Team Agent

The police duty is opening up roads obstructed by debris and fire brigades duty is to put out fire to diminish the damage as far as possible. The ambulance duty is to rescue individuals from beneath the debris and transfer them to hospital.

If the three teams can cooperate with each other well, the number of rescued civilians increases and the rate of damage decreases.

---

[1] Ant Colony System

Our paper consists of five sections. In the second section we study the algorithms the police use to clean up roads and make transportation easier. In the third section we describe the fire brigade duty. In the fourth we study the algorithms the ambulances use to find the injured individuals and transfer them. And in the end we talk about the algorithms used by the agents to go to different spots of the city.

2 Police Force

In general the police's duty is to open up routes which have been obstructed by the debris of buildings.

The falling of buildings is common after earthquakes which their debris obstruct the routes which will trouble traffics. The traffic of these routes must be controlled by the police especially for ambulances and fire trucks.

To facilitate police work and speeding up the movement of automobiles we must find the super nodes in the present graph.

Super nodes are nodes which have the highest grade and are located in the important spots of the city. Afterwards we complete the graph with these nodes, meaning that we should find the shortest routes which connect these nodes together. Then by using the ACS algorithms we find the shortest Hamilton route between these nodes. In this case we will clean up a Hamilton cycle of the city by the police agents, so that our agents will be able to reach all parts of the city. Therefore after opening the obstructed routes in the Hamilton cycle each police can choose one of the jobs below:

- Staying in the same region and cleaning up the routes connected to it.
- Responding to call for help from other agents.
- Cleaning up roads which make a shorter route between two nodes in the Hamilton cycle.
- Cleaning up more sensitive regions for the urgent regions which are on fire.

We use Q-Learning[3][4] method for the police to choose a specific duty. By this means the police choose a certain duty by overlooking its past experiences which are given before.

In Q-Learning we train the police with the values given below:

- The number of civilians located in the specified area.
- The number of agents located in the neighbor areas.
- The numbers of requests for clean up in that area.
- The number of roads that have been cleaned up in the recent time period.

3 Fire Brigade

The fire brigade agent duty is to put out the fire of burning buildings so that it does no further damage to them. Each fire brigade agent decides upon the amount of water supply he has got and the following circumstances:

- Situation of the building on fire.

- The time required to put out fire.
- The number of civilians in danger.
- The direction of the wind.

The situation of a building is determined by the number of buildings around it which are in danger of getting on fire.

4 Ambulance Team

An ambulance team agent has the responsibility to rescue the individuals from underneath the debris and take them to hospital. Also most points of the competition RoboCup Rescue go to the number of rescued civilians. So a method should have been designed that finds the civilians intelligently and transfers them. This method is designed according to the civilian reactions in urgent situations[1]. Each individual shows a specific reaction based on its situation. If this situation is not normal but an urgent one, these reactions will be more complex and vaster, and sometimes it may be irrational; now if we do not take these exceptional reactions into consideration we can categorize these behaviors in more general groups, and predict the reaction of a great number of people. With this prediction our ambulance team agents will go to the location with more possibility of finding injured civilians and rescue them by the information gained about the area.

Each ambulance team agent searches for people and decides upon rescuing them according to the following items:

- Audio-visual information gained about the area.
- Information received from other agents.
- Individuals injured more severely and their HP decreases faster.

This decision is made through the Extended Q-Learning[5] method. Depending on the situation of an ambulance team agent, the situation of the current and previous cycle, and the training given to him before, he chooses one of the items mentioned above and searches for the injured civilians.

5 Route Tracing

In order to reach the specified locations our agents have two choices:

- Using the routes already opened up by the police
- Going through routes not having been cleaned up yet

As time passes, usage of the first choice increases. An agent in each node in order to go to his specified location first finds the fastest route; if the specified route is already cleaned up by the police he goes through it, if not in addition to choosing the mentioned route he sends a message to the police to clean up the route. In calculating the fastest route the degree of obstruction by the debris is studied by the agent

6 Conclusion

Not to lose any cycle in the simulation process, in each stage we try to predict the required jobs to be done in the next step. For instance clearing the super nodes in the beginning and finding areas with higher rate of loss of life.

The algorithms we have used in this system are satisfying so far, but with the growing of the Rescue Field new solutions are needed.

So we are trying our best to make our simulation closer to reality.

7 Further Work

One of the facts that will help our agents cooperate better with each other is the communication between them. At the time we are working on a communication network in which each agent is connected with the others. This communication network must have the capability of giving an "Importance Value (IV)" to each message, and choosing the best agent to receive it by knowing the situation of all the agents.

References

[1] K. Shinoda, I. Noda and M.Ohta "Behavior Design of Civilian Agent for Rescue Simulation", Proc of challenges in open agent system /AAMASO2, PP 135–138, 2002.
[2] M. Dorigo and L.M.Gambardella "Ant Colony System (ACS): A Cooperative Learning approach to traveling salesman problem", IEEE Transactions on evolutionary computation, Vol.1 No.1, 1997.
[3] R.S. Suttun, A.G. Barto "Reinforcement Learning: An Introduction" MIT press, Cambridge, MA 1998.
[4] J. Hu and M.P. Wellman "Multiagent Q-Learning" Journal of machine learning research, 2002.
[5] S. Enokida , T. Ohasi, T. Yoshida and T. Ejima "Extended Q-learning : reinforcement Learning using Self-Organized State Space", RoboCup 2000:Robot soccer world cup IV, lecture notes in artificial intelligence 2019, Springer, PP129-138, 2001.
[6] http://kiyosu.isc.chubu.ac.jp/RoboCup/Rescue