RoboCup 2017

Rescue Simulation League Team Description

CSU_Yunlu(China)

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Abstract

The main work about CSU_Yunlu Rescue Agent Simulation Team within a year is introduced in this paper. Firstly, an estimation function based on K-means algorithm is leveraged to divide the city into different areas. Then another function based on Ant Colony Optimization enables the agent entities to choose the optimal path for consumption, rescue or cleanup.

1 Introduction

The purpose of Rescue Simulation League is to decrease the life and financial losses caused by nature disasters such as earthquakes, floods and etc. In order to achieve this goal, a large urban disaster is simulated. The simulation platform, RoboCup Rescue Simulation System (RCRSS), can simulate the real world's limits and problems as accurately as possible [1]. And the system also exploits the technologies of artificial intelligence and data mining.

Our CSU_Yunlu team has began to participate in RoboCup Rescue Simulation competition since 2006, and we won the fourth place in RoboCup 2016. Major improvements on our rescue policy and code since 2016 are summarized in the remainder of this section [2].

The main contents of this article are listed as follows:

1) Large volumes of data, data dynamic model using k-means algorithm to divide the region of the partition.
2) Ant colony algorithm is used to find the path to make the best path.

2 Zoning

The K-means algorithm is suitable for the model with a large amount of data, and the data can be dynamically changed. The number, location, and environmental factors of the agent will change with the change of the simulation cycle in the rescue simulation task. So we need to solve the dynamic environment in the environmental factors of the injured people in the district. Specific steps are as follows:

1. First of all in the environment map of the injured people in the location of data preprocessing, the formation of the initial data set denoted by X .
2. By improving the K-means algorithm, we first determine the number of K of the initial cluster centers, and then perform the improved K-means algorithm to get the final classification information, centroid of each final cluster is denoted by $m_1, m_2, \ldots, m_c$, and the classification situation of the data set $x_1, x_2, ..., x_n$.
3. We will add the tasks that belong to the same category separately, and get the tasks $T_i (i = 1,2,..., K)$ needed for each classification.
4. Assign tasks to the post classification agent.

We use the K-means algorithm to partition all the injured people. We need to assign all the injured people in the area to the rescue agent. We use the auction algorithm to allocate rescue tasks. When the task is assigned to the agent, the agent will maximize the utilization rate of the resource, and the benefit of the whole system will be the largest, which is calculated as:

$$\max \sum_{j \in k} \left(U_j - \sum_{i \in n} C_{B_i}^{T_j} \right)$$

The U_j said the task T_j efficiency, $C_{B_i}^{T_j}$ is the rescue agent B_i to complete the task of T_j price (bid price of B which is the agent, not assigned tasks for each task T_j , we need to define the task:

$$P(T_j) = \gamma \left(U_j - C_{B_i}^{T_j} \right)$$

Where γ is the proportional coefficient, because in the process of task allocation, we may not like the traditional auction, the highest bidder, in the assignment of agent rescue mission when we

take is the winning expectation benefit maximization, the overall effectiveness of the highest bid system. We define the expected benefits as:

$$E(X) = \arg\max_{j \in N} \gamma \cdot P \cdot (U - C)$$

$$P_i^k = \frac{S_i^k}{\sum_{j=1}^{N} S_i^j}$$

Among them, P is the probability of success for the intelligent bidding , S_i^k for the task of K , intelligent s and other agents have the advantage in the completion of the task.

3 Wayfinding

Ant colony algorithm, also known as ant algorithm, is used to find the optimal path in the graph. It was introduced by Marco Dorigo in his doctoral thesis in 1992, inspired by ants' food-searching behavior. Ant colony algorithm is a simulated evolutionary algorithm. The preliminary results show that the algorithm has many excellent properties. Ant colony optimization (ACO) is a new general heuristic method for solving combinatorial optimization problems, which has the characteristics of positive feedback, distributed computing and constructive greedy heuristic search. Because of the ant colony algorithm has these advantages, many researchers like to use it.

The steps are discussed below.

a) Scope: "ant" observed range is a grid world, " ants " have a parameter for speed radius (3), the scope of it can be observed that the 3*3 grid world, and the moving distance is within this range.

b) Environment: Where the environment is a virtual world, where there are obstacles, there are other "ants", as well as hormones, the hormone has two kinds, one is to find food "ants" shed food hormone, one is to find the nest "ants" shed wo ectohormone. Each ant can only perceive the environmental information within it. The hormones in the environment disappear at a certain rate.

c) Foraging rules: In the scope that each ant can search for food, if there is food the "ants" will go there directly, otherwise to find the pheromone. And it is very sensitive to pheromones, so that it moves toward more information. But each ant makes a mistake at a small probability, so it doesn't have to move to the most pheromone. The rules of the ant's nest are the same as above, except that it reacts to the pheromone of the nest, but does not respond to food pheromones.

d) Mobile rules: each "ants" are the most hormone outward direction, and when there is no external hormone guidelines around the "ants" will be in accordance with their original inertial

motion direction and motion going in the direction of motion has a random small disturbance. In order to prevent the "ant" circles, it will remember recently passed what, if found to go for the next point has recently passed, it will try to avoid.

e) Obstacle avoidance rule: if the ant moves in the direction of the obstruction, it will randomly choose another direction, and there are hormones, it will follow the rules of foraging behavior.

f) Sow ectohormone rule: each "ants" in time just to find food or nest and the hormone most, and with it went the distance, seeding less ectohormone.

The essence of this optimization process lies in:

a) Selection mechanism: the more pheromone path, the greater the probability of being chosen.

b) Update mechanism: the pheromone on the path will increase with the increase of ants, but also gradually fade away with time.

c) Coordination mechanism: ants actually communicate with each other through secretions to work together.

Ant colony algorithm is to make full use of the selection, update and coordination of the optimization mechanism, that is, through the exchange of information between individuals and mutual cooperation to find the optimal solution, so that it has a strong ability to find a better solution.

4 Ambulance Team

The rescue team needs as much as possible to rescue the agent trapped inside the building, sometimes a rescue team, fire brigade and police trapped in a building, this time, first rescue the Rescue team, fire brigade and the police may have better results. Therefore, task allocation is very important and it requires an accurate and efficient decision. In recent years, we have optimized a number of modules, such as work partitioning, task update, task allocation, and rescued object management, etc. Recently, we did some of the following changes according to the original behavior.

a) We revised the priority of the rescuers to make it more reasonable.

b) When the rescue team is trapped, the fire brigade or the police, set the priority to rescue these agents.

c) Set Priority to rescue the dangerous location of the gas station and other trapped people.

d) In the case of a gas station may explode to choose to give up the area near the gas station to save themselves.

e) In calculating the rescue time, the correction time will be increased according to the calculation time. There must be a certain relationship between the correction time and the rough calculation time. For example, when the subject is next, the correction time is zero. By this method, it is possible to ensure that all subjects use the same treatment method

5 Police Force

The performance of police agents to remove barriers will affect the efficiency of rescue. As a result, we optimized some modules, such as work partition, task allocation, priority cleaning objectives, explicit methods, etc. Recently, we have made the following changes according to the original behavior.

In our new strategy, we will give priority to the development of clean target channels. Such as priority to open up to the gas station near the consumer channel to prevent the rapid spread of the fire to the gasoline station, and the priority to open up to the point of water channels to ensure that the fire brigade can have enough water.

Of course, priority will be given to cleaning up the fire brigade, rescue teams and police roadblocks. They will then be able to clear the key areas (shelters, intersections, etc.), and then they will clear some important areas, such as the entrance to the building. At the same time, police agents will broadcast the news of the building on fire.

We need to clear the main roads so that other agents can pass. For some blockades, they do not need to be clear at the beginning of all simulation. Simply put, we usually choose the midpoint of the common boundary (which is also on the edge of the next region of the path) as our clear direction.

6 Fire Brigade

Fire is mainly responsible for firefighting. On the basis of the past, we do some optimization strategy.

a) When the fire can be controlled around at the refuge, give priority to fire at the refuge.

b) Set the priority for hydrant water replenishment.

c) Giving priority to extinguish the fire may be extinguished gasoline station

d) After the fire out of the petrol station to check whether it is possible to burn again

e) Using the cluster to give up other buildings to control fire.

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References

[1] RoboCup rescue website. http:/roborescue.sourceforge.net/

[2] Jiang F., Zhang X., Peng j., Tian H., Luo H., Chen Y., RoboCup Rescue 2016-CSU_Yunlu Rescue Simulation Team Description.

[3] Stuart J. Russell, Peter Norving. Artificial Intelligence: A Modern Approach (M) .Third Edition. Upper Saddle River: Prentice Hall, 2010.93~94

[4] Peng J., Wu M., Zhang X., Xie Y., Jiang F., Liu Y. A collaborative Multi-Agent model with knowledge-based communication for the RoboCupRescue simulation. *International Symposium on Collaborative Technologies and Systems*, Las Vegas, USA, May, 2006, pp: 341-348.

[5] Peng J., Liu Y., Wu M., Zhang X., Jiang F. State Prediction based Dynamic Cooperation Algorithm in Multi-agent System. *Journal of System Simulation*, 2008, 20 (20), pp: 5511-5515.

[6] Liu R., Sun Z. A DBN Model for Fire Spreading in RoboCupRescue Simulation. Collected papers for RoboCup 2007 conference 2007(21)

[7] Guan D., Xu Y., Tan Y. Particle Filter Based Study of Fire Forecasting in RCRSS. Nanjing: Southeast University, 2009

[8] Hao X., Cheng M., Wong V. A Stackelberg Game for Cooperative Transmission and Random Access in Cognitive Radio Networks. in Proc. *IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, Toronto, Canada, September, 2011, pp: 411-416.

[9] Scutari G., Palomar D., Pang J., Facchinei F. Flexible Design of Cognitive Radio Wireless Systems. *IEEE Signal Processing Magazine*, 2009, 26 (5), pp: 107-123.