IranOpen 2014 – Rescue Simulation League Team Description
<Kherad (Iran)>

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Abstract. Kherad team was formed in spring 2013, consisting of two members. For improving the level of the competition each year codes are being released in rescue simulation league. Therefore kherad team decided to use S.O.S base code as its base. At Iranopen robocup competitions, 2014, Iran Kherad team was ranked 5th and ranked 4th at RoboCup Competitions, 2014, Brazil.in summer 2014 nine other members were added to the team. This combination caused new ideas to the strategies, and therefore enhanced the team's performance greatly. However in 2015 the number of the members decreased to two. Last year many ideas and strategies were added; so there wasn't enough time to optimize them. As a result of that, this year, the focus was on optimizing and debugging last year's strategies.

1. Introduction

Each year millions of people die because of natural disasters. These statistics can be decreased to the minimum with a constructive disaster management. The idea of the rescue simulation league is to arrange a platform based on reality in witch rescue operation strategies can be tested on. This project is a new practical domain of Robocup, found to provide essential decision support by integration of disaster information, prediction, planning, and human interface. A generic urban disaster simulation environment is constructed on network computers in which heterogeneous intelligent agents such as Fire brigade, Ambulance team, and Police officer conduct search and rescue activities. Real-world interfaces such as helicopter image synchronize the virtuality and the reality by sensing data. For disaster researchers, RoboCup Rescue works as a standard basis in order to develop practical comprehensive simulators adding necessary disaster modules. This paper explains Kherad's work in this area.

2. Assigning

This year the algorithm used for assigning fire brigades has changed; and now it is according to convex hull algorithm [13]. This method inputs fiery buildings' coordination. And outputs the boundary of the buildings which is the congestion of dots. Fire brigades will be assigned to that side of the fire zone which has the most congestion of dots and the least distance from both center and gas station.

Last year the general formula's operation wasn't accurate enough. In the big maps, the agents were diffused while it was better if a number of them were centralized in one part of the map. This way that specific part will be under controlled. Therefore we divided the map into a number less than number of all the fire brigades of the map and gave each cluster only one agent. According to the convex hull algorithm the rest of the agents will be assigned to a specific part of a map. This will cause the agents' actions to be more synchronized.

The variables that were related to fire zone's distance from center and gas station have changed. These variables will be calculated according to the convex hull method. Instead of calculating the distance of the fire zone's center from the center of the map and the gas station, the distance between the set of the dots and gas station will be calculated. We have also considered coefficients for the factors in the formula. For example the impact of the area which caused problems in the big maps has now decreased. Also some factors in the formula had an unfavorable impact on the weight.

3. Agents/Agent skills and action selection

1- Fire Brigade Agents

Fire brigades duty is to extinguish the fire or to prevent it from extension while there are fiery buildings in the map. For decreasing the damage, the best strategy is the one that puts out the maximum fire in the minimum time.

1.1 Scoring

The score given to each firezone is calculated according to some factors [12]. This year a factor has been added to the formula:

Number of Civilians near firezone:
The more civilians there are around a firezone, the more damage it causes. As a result of that the firezone that has more civilians around gets a higher score.

$$Weight\ Firzone = \left(\frac{Area_{fz}}{maxArea_{fz}} + \frac{\#Neighbour_{fz}}{maxNeighbour_{fz}} + \left[1 - \frac{CenterDis_{fz}}{maxCenterDis_{fz}} \right] + \frac{numberOfNearCivs}{numberOfAllCivs} \right)$$

Area, Neighbour and CenterDis are referring to the area of the considered firezone, number of neighbors the firezone has and the distance to center of the map, respectively.

This year some coefficients have been added to the previous building scoring formula:

$$Weight\ Building = \left(1 - \left(\frac{GasstationDis_b}{maxGasstationDis_b} \right) + \frac{Area_b}{2maxArea_b} + \frac{2Temp_b}{maxTemp_b} + \frac{\#Neighbour_b}{maxNeighbour_b} + \frac{1}{predictFieryness_b} \right) * \frac{CornerDis_b}{maxCornerDis_b}$$

GasstationDis, Area, Temp, Neighbour, predictFieryness and CornerDis are referring to the distance from the building to the nearest gas station, the area of the considered building, temperature of the building, number of neighbors the building have, how likely it is for the building to get on fire and the distance to corner, respectively.

When a fire brigade faces a new fire zone, during doing its task, according to some parameters (for example number of fiery buildings and the importance of its last task and etc.) it decides whether to interrupt its last task and extinguish the visible firezone or not.

1.2 Agents coordination and communication

This year the focus is on low and no level communication strategies because of the problems that existed last year.

1. Low communication

It is important for the fire brigades to be aware of other clusters fiery buildings in low and no communication. For this purpose one of the police agents who is in charge, searches the whole map and informs the fire brigades in some specific cycles and coordinates. If there was no defined task the fire brigade checks the neighbor clusters for fire zones. Also if it was possible the fire brigades use message system.

2. No communication

The strategy used for no communication is similar to the low communication strategy. However in no communication using the message system is impossible.

These actions take place to ensure that the agents are at least relatively aware of any fire that is damaging the city. As a result, the fire that may have started is less likely to go unnoticed.

2-Ambulance Agents

The main responsibility of the ambulance agent team is to rescue the maximum number of civilians possible. For this cause agents should be able to decide properly by giving an appropriate cost to each civilian. This way the chance of rescuing a larger amount of people increases.

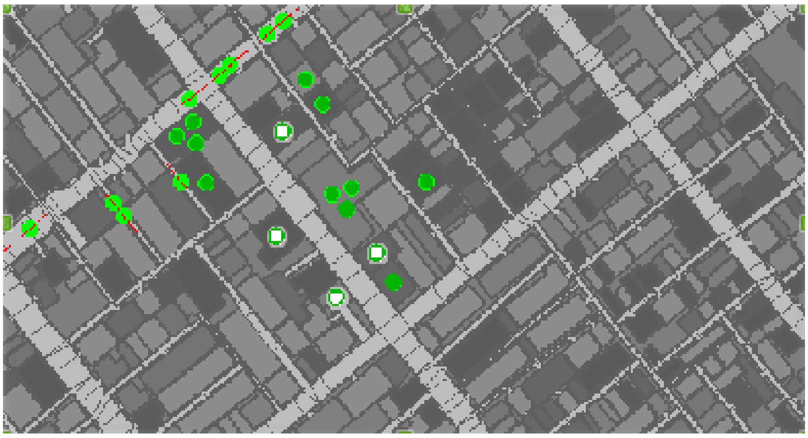
2.1 States

Civilians who are around fires are at a lot of risk and should be rescued immediately. Therefore this year a state has been added which prioritize civilians near fire at first cycles.

2.2 Choosing civilian

At first, Clusters which comparatively have a high population will be specified. Civilians of these clusters will be divided into ranges of fifteen according to their death time. Civilians who have a death time higher than two hundred will not be contained .once again in a range which contains the most number of civilians will be defined. The same process will be repeated for the other clusters. The average rescue time in each range will be calculated (according to rescue time formula). At last three closest neighbors will be assigned to the defined cluster based on the rescue time.

Civilian’s rescue time= ambulance free time + civilian’s movetime + buriedness + movetime to refuge (this formula will give the time in which the civilian will be rescued)



1. Ambulances prioritizing a cluster to their own because of its high population in a low or no level communication map

Since in high-level communication all agents message their prominent information to center, center is the best one to decide which civilian is the most valuable.

At first each ambulance searches its own cluster, according to some factors such as number of civilians, civilians’ burriedness, etc. Then the cost of the cluster will be calculated and sent to the center. Center will make a list out of the cluster’s costs that the agents have sent. Center assigns the agent with the least value to the cluster which cannot be handled properly. After some time in which agent’s new cluster is almost handled the agent will get back to its own cluster.

2.3 Ambulance decision

1- Full-Level Communication

Since all the messages will be sent accurately, in high-level communication each agent will be informed in which cluster it should work by center. Then each ambulance would make a list consisting each civilian along with a cost calculated for it. At last, based on civilians’s costs and each’s movetime, agents will decide which civilian should be rescued first.

One significant issue in high-level communication is the communication between ambulances and fire-bridge agents. Ambulances can inform fire-bridge agents by messaging them about a fire occurring in the map which might be dangerous for lots of civilians, or on the other hand, fire-bridge agents can inform ambulances about a filled-civilian place in the map. Center will decide if the ambulances should go to where they have been formed of or not.

2- Low-level communication

In low level communication not all the messages will be received accurately. In this level of communication the agents will search their cluster and the one next to it for an approximate 30 cycles. If its neighbor cluster has a cost more than a specific number the agent will stay in the cluster. Elsewhere it gets back to its own cluster. One factor in low-level communication is the existence of Virtual Civilians. Virtual civilians are those whose information is not accurate enough for a reliable scoring. The ambulance would give a cost to each virtual civilian. Choosing a civilian that its information might be wrong is not worth the time.

One of the risks in low-level communication maps is the same decision made by two ambulances. In case of that each ambulance should know the other ambulance’s decision making algorithm (the one that is working in the same cluster). Therefore, they won’t choose the same civilian to rescue.

3- No-level Communication

The only way of communication in no-level communication is by talking in a short distance. The strategy used in no-level communication is similar to low-level communication strategy, with the difference of no virtual civilian’s existence.

3- Police Agent

The police agents' responsibility is clearing the roads from blockades and making transportation between different points of the map available. This agent's strategy is based on clustering which has been explained above.

3.1 Interrupts

This year some limitations for interrupts has been added. Therefore no main task is at risk of running out of time.

3.2 Prioritizing/ States

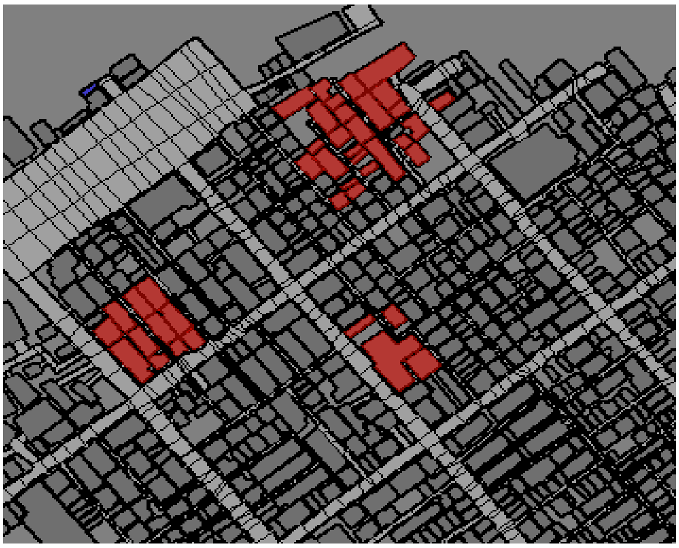
This year two states have been added to the previous ones [12]. After all of the tasks mentioned are done police agents will look for hydrants and civilians which are still blocked and will open them. In order for ambulance agents to do their tasks properly, it is police agents' duty to make sure civilians' of higher priority to the ambulances path is clear. In order to choose civilians which are prioritized, this year police agents' and ambulance agents' civilian choosing formula has become more consonant.

Fire agents cannot fulfill their duties unless they have a way for reaching the fire that is spreading. Each fire zone will be classified as "firezone type1", "firezone type2" or "firezone type3" according to number of buildings it consists of.

$$AgentsNeeded = \frac{numberOfAllPolices - numOfclosedRefuges - numOfOnFireClusters - numOfStuckAgents}{\left[2 * numOfType1Firezones\right] + \left[6 * numOfType2Firezones\right] + \left[12 * numOfType3Firezones\right]}$$

numOfAllPolices, numOfclosedRefuges, numOfOnfireClusters, numOfStuckAgents and numOfType1Firezones (for example) are referring to the number of police agents in the map, number of refuges which are blocked, number of clusters which fire is occurring in them, number of agents which are stuck in the roads and number of firezones classified as type1 in the map, respectively.

According to the above-mentioned formula and some calculations the optimum number of police agents for each firezone is calculated. For assigning these agents the following steps are taken: Firstly, The distance between all clusters' centers to the specific cluster's center (the cluster which is on fire) is calculated. Then the clusters sort by their distances. Police agents which have the least distances (based on the number of agents needed) will be assigned.



2. An example of a firezone type1, type2 and type3

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