Robocup Rescue Simulation Agents

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Abstract. The Bam team was established in 2003 under the supervision of Dr. Zamanifar, the leader of the Robocup Simulation group in the Computer Engineering Department of Esfahan University . Our research field is multiagent learning techniques used in Rescue Simulation project with least communications (part of the Robocup competitions).

1) Police force agent:

Police agents are responsible for cleaning blockades and controlling roads.

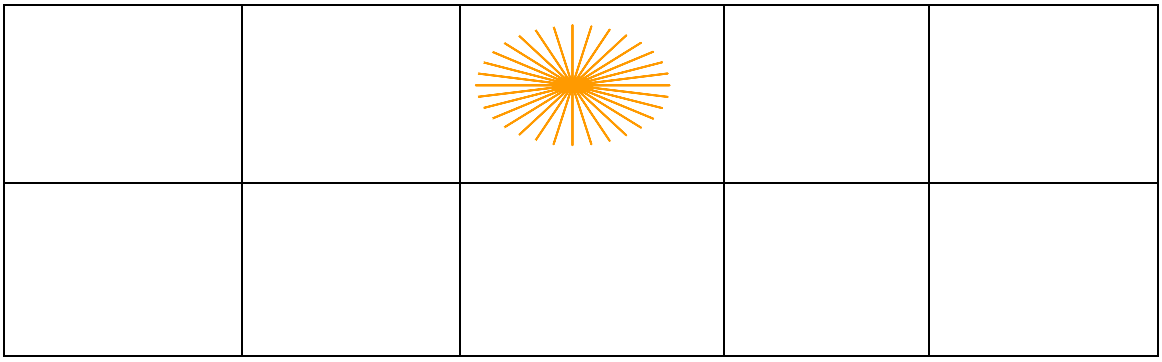
We thought that it is best for agents to work individually and autonomously. To reach this end, we had to make some divisions, the divisions must be in a way that the least amount of messages are needed because there are limitations in number of messages.

First we came up with dividing the area by road IDs. This way during the first couple of minutes the police center sends a range of IDs to each agent so they will find the appropriate road , check and clear them .

This plan failed , because Ids are randomly distributed and roads are scattered on the map therefore agents had to travel long distances to reach the roads and traffic congestion increased and agents' performance declined.

To avoid this problem we used coordinates to divide the working area. Division takes place in the police center on the basis of the number of the policemen; and the police center allocates a number to each zone. After that, the police center sends a zone number to each agent. From the total number of zones and the zone number that has been sent to an agent via the police center, the agent finds out which roads it must check and clear.

For example we have 10 police agents and each agent knows its zone number and each agent finds out the length and width of the map from the world. Then the agent checks the zone number. If the zone number is less than 5 its zone will be in the first row, and if the zone number is more than 5 it will be in the second row. Suppose that number 3 has been send to one police agent, therefore the agent will choose the highlighted area shown below:



In order to avoid missing roads that are located on borders we consider a tolerance for each zone, so areas will overlap each other.

We intentionally do not place the agents in their predetermined zone, because this way each agent has to travel to its zone through the important roads and at the same time clears all blockades, that are in its path. Thus, important roads between zones will be cleared due to this method. We have devised police agents that will travel through the shortest path between zones even if it is closed as a result of this, all the important roads will be cleared initially.

Another point worthy to mention is that we tried to simulate what actually happens in real police centers. In real police centers, the head policeman allocates each suburb of the city to a number of policeman and they are responsible to control their suburb. If there is no problem in one suburb the idle policemen help policemen in other suburb.

Another problem we encountered is that sometimes a police agent finishes its duties sooner because comparing to other zones its zone might have fewer blockades. To make this agent more useful we considered dynamic zones due to this, when a police agent finishes its job in its zone, the agent adds the beside zone to its zone so it will help the other police agent in the other zone. This procedure is done without sending any message. After awhile each agent 's zone extends and in the end there will be one zone where, all agents are working at it.

We define two modes for policemen, Emergency and normal. Emergency mode is used when other agents such as fire fighters and ambulances are stuck in a road. When emergency mode is active, policemen will leave their zone and will help stuck agents.

When the normal mode is active, policemen work in their areas, however if other agents (ambulances and firefighter) come across a blockade in there way they will come back and find a new route and simultaneously they will send a message to policemen and inform them that there has been seen a blockade in their way.

2) Fire brigade agent:

Fire brigades task is finding fires and extinguishing them. Our main idea is extinguishing edge fires first so that fire can not propagate through neighborhoods.

For the selection of this fires we should choose from fieriness buildings one that has more unburned neighborhoods in total area . so we reduce the importance of buildings that are in the end points of the city that have no burnt neighborhoods.

We also increase the importance of burning buildings in the middle points of the city because they have more neighborhoods for burning and should be extinguished sooner than others. Another advantage is that it intercepts large buildings from burning.

In addition to this important parameter, we use others factors with lower class priority such as :

a) Building kinds (wooden buildings have more priority).
b) Neighborhood kinds.
c) Total area of a burning building.
d) Time passed since the start of a fire in a building.
e) Number of civilians in a burning building.
f) Number of civilians in the neighborhood of burning buildings.

We use some weights of these parameters in a priority function so that can get the best answer for most different maps.

With estimating the water quantity for extinguish can know the number of fire brigades that are needed.

When fires are near to each other, fire brigades work all together on a burning point with maximum priority and with least communication. But when fire points are far from each other, fire brigades are divided into groups each working on a fire point.

So other agents should send fire points in messages. Police force agents in different zones do this task to reduce communication, fire points are only sent once.

Fire brigades try to ignore fires that are in far distances until near fires are extinguished completely, then go to far fire points. This causes fire brigades to concentrate in one point and not switch from one point to another iteratively. Because too much time is taken by moving iteratively between two points and none of them can be extinguished completely in a short time and both fire points are expanded in different directions, in the above approach one point is expanded and the time lost moving between different points can be used to extinguish a fire. This decision also reduces traffic and improves efficiency .

Also in decision we try to ignore fire points that take longer to be extinguished, and pay to other points that can be extinguished in a shorter time and prefer it's neighborhoods to be burnt and then extinguish the neighborhoods in future cycles.

Firefighters send help messages to ambulances when their buriedness is greater than zero and send blockades to polices when they stop behind a blocked road.

To reduce the distance limit between fire brigades and fire points, firefighters can go to buildings which are not burning around a fire point other than entrances. Another advantage of this technique is reduction of traffic around of the fire points and most times blockades around roads of fire points don't need to be cleared because they can be reached from different points and different roads near to fires.

3) Ambulance team agent:

In this system ambulance team agents search injured civilians distributed and free of others in the city. Ambulance teams can hear the voice of civilians in buildings with searching different roads and by crossing buildings or see them. This is better than searching all of the buildings and results in time reduction. reduce time.

With reception of the injured civilians or agents' information all of the ambulance team try to rescue the most important injured by priority. Fire brigades have first class priority because they should be ready sooner for fire extinguishing. So by sending massages to the ambulance team, all of the ambulance agents come to the rescue. Second priority is for police and third class priority for civilians.

In each of this priority classes we define a priority function to select the most important injured agents or civilians in any class so that any agent calculates its own "living hope" every time. The living hope parameters is:

1) Civilians damage.
2) Civilians hp value.
3)Buriedness of civilians.
4) Number of ambulances that came for rescue.
5) Necessary time for rescue.
6) Position of civilian (in burning building or not).

By estimating of living hope the most important civilian is selected so that any agent or civilian that can not be live before going to refuge should be eliminated from the most important queue; also someone that can stay alive after unloading in refuge. So someone that has a middle status that can stay alive if tried and else will die.

Between all of the ambulance teams that go to a building, one ambulance candidate to load the injured civilian and take it to refuge, after being rescued. Each ambulance team after finding injured civilians, reports them to others so that all concentrate in one civilian. This causes on concentrating on them and earlier rescue and intercepts from a fast decrease of hp of that civilian.