

# The Team Description of YowAI2003

Hiroki Endo, Takeshi Morimoto, and Ikuo Takeuchi

Department of Computer Science, University of Electro-Communications,  
1-5-1 Chofugaoka, Chofu, Tokyo 182-8585, Japan,  
[hiroki-e@takopen.cs.uec.ac.jp](mailto:hiroki-e@takopen.cs.uec.ac.jp),  
<http://ne.cs.uec.ac.jp/~hiroki-e/>

**Abstract.** RoboCupRescue project aims to simulate large urban disasters. In order to minimize damage resulting from disasters, various rescue agents try to accomplish their missions in the disaster space in the simulation system. Ability of an individual agent, however, is utterly insufficient. Agents need to cooperate with other same and different types utilizing as little communication as possible under stringently limited visual sensory information. Our YowAI2003 team solved future work of YowAI2002 in RoboCup2002 and realized their cooperation with simple and short format message communication.

## 1 Introduction

RoboCupRescue project aims to simulate large urban disasters. Rescue agents such as ambulance teams, police forces, and fire brigades act on the disaster space in the simulation system. Buildings and houses collapse and burn, and roads are blocked in the disaster space. So a number of civilian agents are sacrificed and injured. In order to minimize damage resulting from disasters, these agents have to try to accomplish their missions.

Many agents such as civilians, ambulance teams etc. lived in the disaster space. Soon after the large earthquake, buildings collapse, many civilians are buried in the collapsed buildings, fires propagate, and it becomes difficult for agents to move roads because these are blocked by debris of buildings and something else.

In the disaster space, there are seven types of agents; civilian, ambulance team that rescues injured persons and take them to refuges, fire brigade that extinguishes fires and arrests the spread of fires, police force that repairs blocked roads, ambulance center, fire station, and police office. The number of Say, Tell and Hear commands that can be issued by an agent in one turn is limited. When an agent receives hear information from the simulation system, the agent may select whether it hears individual messages or not by checking who is the speaker. Introducing the revised rule, it becomes difficult for RoboCupRescue agents to recognize the condition of disaster space. In such a situation, RoboCupRescue agents must rescue civilians and minimize damage from disasters.



**Fig. 1.** Disaster space

## 2 Fundamental abilities

RoboCupRescue agents were not often caught by a traffic jam. For rapid rescue operation, the agents have to avoid causing a traffic jam as far as possible, and untie it by looking at others if it occurs. Our agents untie a traffic jam by using communication among agents. Once our agents are caught in a traffic jam, they recognize their surrounding circumstances. Agents which are caught in a traffic jam request moving out of their way. At the same time, agents which cause a traffic jam move not to cause a traffic jam.

## 3 Cooperation strategies

### 3.1 Fire Brigade

Fire changes its condition rapidly, so it must be especially rapidly coped with. It may not be difficult to extinguish an early fire for even a few fire brigade agents. On the contrary, it is very difficult even for many to extinguish a late and big fire. Time is valuable very much. It is better that individual fire brigade agent selects fire on its own responsibility, than spending time to communicate with others.

There are four tactical points about fire fighting;

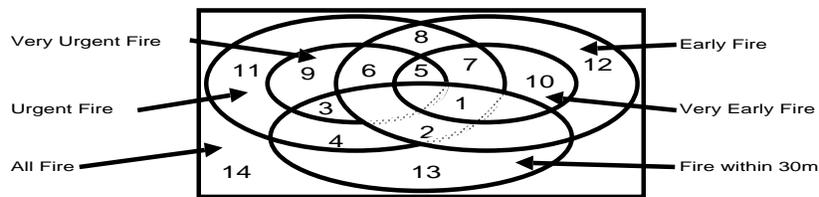
- give early fires a top priority,
- barricade by extinguishing edges of spread of fires,
- concentrate flashing power as far as possible, and

- distribute power as far as possible finally.

It is wasteful that many fire brigade agents extinguish a small-scale fire, and it is ineffective that a small number of agents extinguish a large-scale fire. However, under a situation where fires are scattered, it is a formidable task to balance concentration and distribution of flashing powers.

YowAI2003 becomes possible to distribute fire brigade agents efficiently by estimating the priority of fires based on five criteria;

- whether the buried exist or not,
- state of the fire, especially burning duration,
- possibility of spread of the fire,
- surrounding circumstances of the fire, and
- distance from the agent to the fire.



**Fig. 2.** Priority of fire

Fire brigade agents look at the surrounding circumstance of the fire to estimate whether fire spreading can be blocked by extinguishing it. If extinguishing the fire is useful for blocking of fire spreading, then it is valuable. The value of fire extinguishment is calculated with the numbers of yet unburned buildings, extinguished buildings, burning buildings and the buried around fire. To be specific, the fire around where are many buried disaster victims, many unburned buildings and few fires is valuable to extinguish, that is, urgent. Fire brigade agents should extinguish such urgent fires rapidly, or the fires probably propagate to the surroundings.

Fig.2 shows the priority of fires which is described by a small integer. For example, the first priority, the smallest integer is given to a fire which is very early and located within a radius of 30m from the agent.

Introducing the revised rule, fire cognition delay and limitation of tank quantity, it becomes harder for platoon agents to recognize the most urgent fire. Firstly, toward the fire cognition delay problem our agents solve the problem by reporting an only fire which each fire brigade is extinguishing presently. It is expected that fire which fire brigade agents is extinguishing is the most urgent fire in surrounding area. By this method, our agents can control the number of

messages. As a result, our agents can hear not only reporting urgent fire messages but also other important messages, for example, information of seriously injured civilians' position.

Secondly, toward the limitation of water tank quantity problem, our agents cope well with the problem by synchronizing the timing of filling water with communication among agents. Our agents extinguish fire and consider other agents' remains of water. Our agents try to fill water at the same time. As a result, our agents can extinguish the urgent fire and be allocated to some fires.

### 3.2 Police Force

Police force agents repair blocked roads through which others need to pass. Other types are often put in a situation that they cannot reach any destinations because routes are cut off. Though they are able to calculate optimal routes, they cannot reach any destinations in such a situation. As previously mentioned, agents must reach their destinations as soon as possible when they need to be there. Activity of police force agents especially affects others'. It is, however, difficult to get a criterion which roads they had better to repair first.

In order to repair more important roads, platoon agents negotiate with each other in advance, and what is more, police force agents consider positions of fires, refuges, other agents and so on. For example, police force agents first clear blockade in multi-lane roads, which are more important than single lane roads in general, and other agents try to pass such roads first. Fire brigade and ambulance team agents can be assured that they will be able to pass blocked roads on where police force agents are clearing and will finish at least a few cycles later.

### 3.3 Ambulance Team

Ambulance team agents search for injured persons in a distributed manner, and concentrate to rescue them together with others by using communication. Ambulance team agents can hardly grasp states of all injured persons, because there are many injured persons and they are often appear suddenly, for example, by the spread of a fire. So it is nearly impossible to optimize a rescue plan. Ambulance team agents put a premium on the certainty, and rescue injured persons soon after they decide it is necessary to rescue just now. In order to restrict rescue operation from which little pay-back can be expected, they divide injured persons into four rescuing priorities; "need immediately", "need", "no need" and "abandon".

### 3.4 Center agents

Under the revised rule, a center agent can tell/say and hear messages up to double number of its platoon agents per cycle. So center agents not only hook up communication with other type agents, but also can make decisions more correctly and quickly. Our center agents take advantage of gathered important information to make decisions on concentration and distribution of platoon agent.

## 4 Conclusions

We made several improvements on YowAI2002 team in RoboCup2002 in order to solve its future work and deal with some problems issued from the revised rules. YowAI2003 team's features are as follows:

- Platoon agents negotiate with each other in advance by using a so-called locker-room agreement.
- Police force agents consider positions of fires, refuges, other agents etc. and estimate more important paths which other platoon agents pass frequently. Accordingly, platoon agents can move to destinations smoothly.
- Fire brigade agents make up information of fires by reporting an only fiery buildings which are flushing. This method has two advantages. First, this method helps fire brigades agents be allocated to some buildings, considering remains of water autonomously Secondly, the number of messages is controlled, and then the efficiency of communication is improved.
- Fire brigade agents consider other agents' remains of water with communication and can be allocated to some fires.
- Ambulance team agents grasp states and positions of injured persons efficiently.
- Center agents take advantage of gathered important information to make decisions on concentration and distribution of platoon agent.

## References

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