RoboCupRescue Simulation League

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1 Introduction

This paper overviews all results of RoboCupRescue simulation league at 2002.

RoboCupRescue simulation has a lot in common with RoboCupSoccer simulation. It handles distributed, multiagent domains and agents do their tasks with limited communication and sensing abilities. The distinctions between rescue and soccer are scales of domain, multiple hierarchies in agents and interactions with various disaster simulations [1]. The agents are firefighters, police workers, ambulance workers and their control centers.

The basis of RoboCupRescue is a disaster rescue scenario in which the rescue agents attempt to minimize damages to civilians and buildings after an earthquake. Agents in a competing rescue team do rescue operations in a disaster world, and cooperate each other to save buried ones, to extinguish fires, to repair roads, etc. The teams do not compete against each other directly like games in RoboCupSoccer. They operate independently in the copies of a disaster world and compare their performance.

It provides not only a platform for Multi-Agent System research domain but also a prototype system for decision support system at public offices.

2 Improvements Rescue Simulation and Changes in Rules

After 2001 competition , several proposals were done and they were discussed over RoboCupResuce mailing list (r-resc@ISI.edu). The following four proposals were adopted.

1. GIS file of a virtual city map,
2. Tools to change parameters that specify magnitudes of earthquakes,
3. Civilian agent modules which actions can be specified as rules,
4. A new traffic simulator that runs stably.

Evaluatin Rule: Rescue operations are themselves multi-purpose activities to save human lives. Their performance is evaluated by a composite metric of human lives, building damages and etc. The followings are metrics used in 2001 and 2002:

$$V_{2001} = L + 1 - \frac{H}{Hint} \times \frac{B}{Bmax}$$

$$V_{2002} = (P + \frac{H}{Hint}) \times \sqrt{\frac{B}{Bmax}}$$

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where L is the number of dead persons, P = the number of agents $-L$ is the number of live persons, H is the amount of HP(health point) values of all agents and the ratio to the initial time, $H/Hint$, shows the efficiency of operations, B is the area of houses that are not burnt, and $Bmax$ is the area of all houses. At 2002, the metric was changed to represent the rescue agent's operations more directly than 2001, because their direct contribution in V_{2001} was less than 1.0.

Disaster Setting: Earthquakes may occur anyplace in the world. Rescue operations will be done in unexpected or unfamiliar situations. Teams are supposed to do rescue operations equally well at two cities, Kobe city and a virtual city (Fig. 1) under various disasters. Following files sets disasters.

- **map of city file** contains the network of road and properties of buildings. Using different maps is equal to be in different cities.
- **gis_initial file** specifies the number of agents - rescue agents and civilians - and their initial locations. The population or locations of civilians are different from morning to night. The parameters in this file represent such situations.
- **dis_initial file** describes the magnitudes of earthquake and how much damages are at where.

At 2002, teams are requires to submit gis_initial and dis_initial files before competition. The files were used for games to create various situations, because teams do not know the content of other team's gis_initial and dis_initial files. This situation stresses planning under real-time constraints are required more than last year.

Fig. 1. Rescue simulation - performance display (left), virtual city map (middle), Kobe city map (right) -

Communication Model: A rescue team is composed of heterogeneous agents - fire brigades, ambulances, polices and their center agents. Center agents can communicate with agents under their commands at remote locations, while the communications among other agents are limited within a specified range (30m). The center agents can collect data from distributed agents under their commands and control them to rescue efficiently. Table 1 shows the range of agents' number that is specified in the gis_initial file. The agents are required to work cooperatively at two conditions - with center agents and with no center agents.

Table 1. Number of agents and ignition points

numbers	min.	max.	numbers	min.	max.
Fire Brigade	10	15	Fire Brigade Center	0	1
Police Force	10	15	Police Force Center	0	1
Ambulance	5	8	Ambulance Center	0	1
Civilian	70	90	Refuges	1	5
ignition points	2	8			

Table 2. List of participating teams

team	country	affiliation
Arian	Iran	Sharif University of Technology
Gemini	Japan	National Institute of Advanced Industrial Science and Technology (AIST)
Kures2002	Japan	Kansai University
NITRescue02	Japan	Nagoya Institute of Technology
RoboAkut	Turkey	Bogazici University
Team WaGuMi	Japan	JAIST/AIST
YowAI2002	Japan	The University of Electro-Communications
Rescue team for Rescue	Japan	Future University-Hakodate

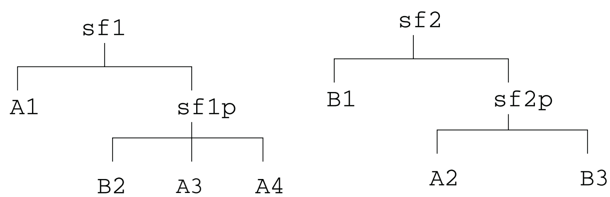

Fig. 2. semi-final games

Civilian Agent as Environment: Civilian agents play important roles in disasters. They may walk to refuges, say at homes, ask for help, or work for helping other civilians. A new framework to describe such civilian's behaviors was proposed and civilian agents implemented by the frame were used [2].

3 Final Results and Awards

Eight teams from three countries (15 teams from 6 countries at pre-registered time) participated this year. Rescue team for Rescue was a system that speaks comments on rescue operations [3]. At team meeting before competition, it was decided that Rescue team for Rescue commented all games using Kobe city map.

The rest seven teams were divided into groups A and B. They got points according to V_{2002} metric. The numbers in tables are V_{2002} metric values and the numbers in parenthesis show the points. The total points in the preliminary games ranked them and decided their positions at semi-final games (Fig. 2).

Table 3. Scores of Preliminary Games

Group A

gis_i f.	YowAI.	NITRes.	RoboAk.	Kures.	YowAI.	NITRes.	RoboAk.	Kures.	total	rank
dis_i f.	NITRes.	RoboAk.	Kures.	YowAI	NITRes.	RoboAk.	Kures.	YowAI	points	
Map	Kobe City				Virtual City					
YowAI.	79 (3)	94 (3)	90 (3)	73 (3)	95 (3)	94 (3)	46 (3)	86 (3)	24	A1
NITRes.	43 (2)	81 (2)	20 (1)	62 (2)	49 (0)	89 (2)	39 (2)	78 (2)	13	A2
RoboAk.	31 (0)	30 (0)	18 (0)	23 (0)	66 (2)	49 (0)	35 (0)	62 (1)	3	A4
Kures.	38 (1)	36 (1)	23 (2)	47 (1)	56 (1)	54 (1)	38 (1)	62 (0)	8	A3

Group B

gis_i f.	Arian	Gemini	TWagumi	Arian	Gemini	TWagumi	total	rank
dis_i f.	Gemini	TWagumi	Arian	Gemini	TWagumi	Arian	points	
Map	Kobe City			Virtual City				
Arian	21 (2)	68 (2)	58 (2)	96 (2)	90 (2)	62 (1)	11	B1
Gemini	12 (0)	26 (0)	17 (0)	41 (0)	64 (0)	49 (0)	0	B3
T.Wagumi	13 (1)	31 (1)	22 (1)	60 (1)	69 (1)	63 (2)	7	B2

Table 4. Scores of semi-final leagues

League 1

gis_i f.	TWagumi	Kures.	RoboAk.	TWagumi	Kures.	RoboAk.	total
dis_i f.	Kures.	RoboAk.	TWagumi	Kures.	RoboAk.	TWagumi	points
Map	Kobe City			Virtual City			
T.Wagumi	23 (0)	28 (0)	17 (0)	47 (1)	55 (0)	51 (0)	1
Kures.	27 (2)	39 (2)	29 (2)	46 (0)	65 (2)	53 (1)	*9
RoboAk.	24 (1)	35 (1)	18 (1)	50 (2)	64 (1)	54 (2)	8

League 2

gis_i f.	NITRes.	Gemini	NITRes.	Gemini	total
dis_i f.	Gemini	NITRes.	Gemini	NITRes.	points
Map	Kobe City		Virtual City		
NITRes.	76 (1)	67 (1)	89 (1)	84 (1)	*4
Gemini	31 (0)	33 (0)	49 (0)	59 (0)	0

Semi-final games

	sf1				
gis_i f.	YowAI.	Kures.	YowAI.	Kures.	total
dis_i f.	Arian	Arian	Arian	Arian	points
Map	Kobe City		Virtual City		
YowAI.	57 (1)	70 (1)	86 (1)	78 (1)	*4
Kures.	36 (0)	40 (0)	58 (0)	59 (0)	0

	sf2				
gis_i f.	Arian	NITRes.	Arian	NITRes.	total
dis_i f.	YowAI.	YowAI.	YowAI.	YowAI.	points
Map	Kobe City		Virtual City		
Arian	69 (1)	76 (1)	86 (1)	53 (0)	*3
NITRes.	23 (0)	67 (0)	55 (0)	88 (1)	1

* marked teams proceed to next stages.

Winner was Arian, YowAI2002 was the second place and the third place was NITrescue02. It was interesting that the top two teams employed different communication models to cooperate their agents. Arian made the most of communications among agents, while YowAI2002 restricted communications. The difference comes from their images or experiences of disasters. Arian from Iran considers that communication such as PDAs, or cellular phones should be used at disaster areas, while YowAI2002 from Japan thinks communication lines will be damaged by earthquakes and not be used as usual at such time.

Table 5. Scores of final and 3rd-place games

Final game			3rd-place final game		
Map	Kobe City	result		Kobe City	result
gis_i f.	YowAI2002			Team Wagui	
dis_i f.	RoboAkut			NITrescue02	
YowAI2002	87.9	2nd place	Kures2002	34.7	
Arian	90.5	winner	NITrescue02	46.5	3rd place

Table 6. Results: Rescue Simulation League

1	Arian	Sharif University of Technology	Iran
2	YowAI2002	The University of Electro-Communications	Japan
3	NITrescue02	Nagoya Institute of Technology	Japan

SICE (The Society of Instrument and Control Engineers) award was given the new traffic simulator developers, Takeshi Morimoto and Tesuhiko Koto.

4 Discussions and Futures Developments

Disaster rescue is one of the most serious social issues that involve very large numbers of heterogeneous agents in the hostile environment. The difference in Arian and YowAI2002's approaches spotlights how the communication model between rescue agents should be. The communication is not only one of key issues of multi-agent systems but also interoperability among rescue teams from various countries in real disaster situations. They are very important from both research and application viewpoints, and will be taken into considerations to rules setting and competition styles.

Others topics that were discussed to be considered in future are evacuation from skyscrapers or underground shopping centers, disaster models at various countries and regions - brick houses or wooden houses - , and the size of a city.

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