Tool kits for using Open Source GIS data as RoboCup Rescue GIS maps

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Abstract. In this paper, we show our tools that automatically generate four GIS related files - node.bin, road.bin, building.bin and gisini.txt - from GIS data that are open to the public.

1 Introduction

RoboCupRescue Simulation Project has purposes to provide emergency decision support by integration of disaster information, prediction, planning, and human interface [6]. To develop the rescue simulation from test bed to real application level, it is needed to test it in various situations.

We think simulations for practical applications should be tested with real data, and the simulation results are analyzed systematically. In this paper, we show our tools that automatically generate four GIS related files - node.bin, road.bin, building.bin and gisini.txt - from GIS data that are open to the public.

2 Map generation from public data

Tools such that generate GIS related files have been provided from RoboCup Rescue community. They are tools for creating polydata.dat files, JGISEdit, and Random Map Generator [4][3][5]. We can create new maps from scratches or edit existing maps using them, however, it is hard to creare a large one.

Various organizations provide free data for real urban road networks[2][1]. In Japan, Geographical Survey Institute national surveying and mapping organization supports digital maps of Japan in XML form. The digital data are 25,000 scale and cover cities over Japan.

Conversion from the XML forms to RoboCup Rescue files consists of three steps.

step 1: conversion to Rescue Format files:
This step is to make node.bin and road.bin files. It is straightforward and the specification depends on the format of GIS data that are open to the public.

step 2: generation of building.bin file:
Generically, personal properties are not contained in the open GIS data.

Data on houses are such personal information. They are key data for disaster simulators, such as fire simulator, collapse simulator and etc. It is necessary to create building.bin files.

step 3: generation of gisint file:

This step creates the gisint.txt file that specifies initial locations of agents. `gis` program in RoboCup Rescue package creates the gisini.txt file when there is no gisini.txt. Our program creates a gisini.txt by specifying how many agents will be located whether on roads or in buildings.

3 Automatic generation of building data

Houses are within areas edged with roads. GIS data contains road information as edges of a network and crossings as nodes. Our automatic generation method consists of two steps. First step generates building areas that are created from edges and nodes of a network. Second step disposes houses into the building areas.

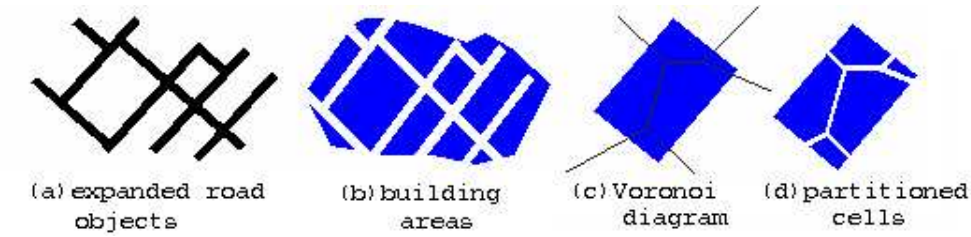

Fig. 1. Building area creation using Voronoi diagram

step A : building area creation using Voronoi diagram.

1. Roads represented as edges are expanded into rectangular objects.
2. The rectangular objects are combined into one shape area. The shape represents one road_ area_ object.
3. Subtraction of the road_ area_ object from a previously defined area gives areas that buildings are.
4. One area is selected form the remainder_area of the subtraction. Put n points on the area.
5. Calculate a Voronoi diagram on the area. The diagram partitions the building_ area into n cells. The cells correspond to plots of a house.

step B : disposition of houses into the plots.

Outlines of houses are designed using GUI interfaces and are stored into a library in advance. Following steps are repeated for every cell.

1. Select one outline randomly from the library.

2. Put the house on the plot in such a way that the centers of the house and the plot correspond.
3. Rotate the house $\pi/2$, π or $3\pi/2$ to make its entrance fits the nearest road.
4. Zoom out the points of outline to the center until all points of the outline are within the plot area.

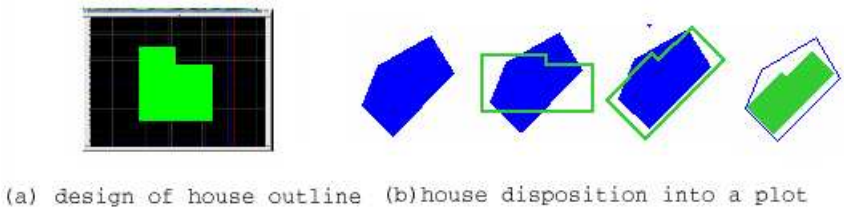

Fig. 2. House Disposition Step

Kobe Map contains building data that were at 1995 when Kobe Awaji earthquake occurred. As Fig. 3 shows the generated one is sparser than real one. Table 3 shows features of maps and not_burnt rates of corresponding maps. The number of points, n, used in calculation Voronoi diagrams correspond to the number of houses. The layout of n points and the selection rule of house outlines may become parameters that determine cityscape types such as inner-city district, suburban residential quarter, business district or factory zones.

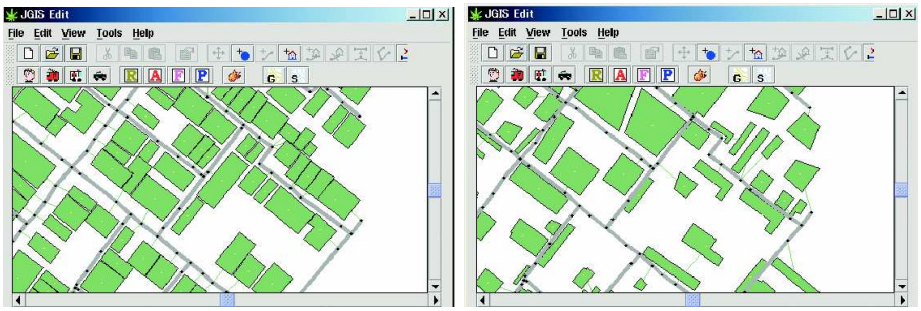

Fig. 3. KobeMap of RCR(left) and genearted map(right)

Table 1. comparison original and generated Map (Kobe)

	RCR map	generated maps		
no. building	740	603	733	512
building area/all building area	50.4%	49.5%	48.9%	22.2%
not_burned rate	61%	84%	86%	75%

4 Examples of created maps

We simulated some wards of Nagoya city where our university is. Fig. 4 are snapshots of the simulations.

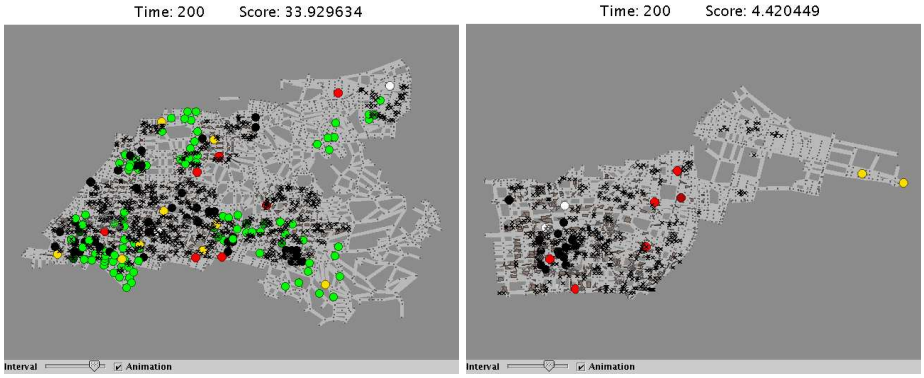

Fig. 4. Rescue simulations for Chikusa(left) and Higashi(right)

4.1 Simulation I

Left two columns in Table 2 shows statistical data (area(km^2) & population). Middle three columns are network properties (the numbers of roads, nodes and buildings of networks). [1] Building data are automatically generated by our method. The numbers of generated buildings are set to be proportional to households.

Initial conditions and parameters are set in the following ways.

agent numbers : The number of civilians are set to be proportional to real population. [2] Three fire engines and two ambulances are deployed to a central

[1] RoboCup Resuce uses three maps at competitions. Foligno map is the biggest of the three maps. It has 1,369 roads, 1,480 nodes and 1,078 buildings.

[2] The numbers of civilian are small compared to the real population. One agent corresponds to one process or a thread. The number of agents is proportional to the resources of computers.

fire station and two fire engines and one ambulances to a substation. Real number of central stations and substations are used. Ten police agents are deployed to every wards.

agent location : They are uniformly distributed over the maps. This setting is assumed that earthquakes occurs in the daytime when people work outside.

fire ignition : Fires break out simultaneously at five points.

Table 3 show the results of Sample rescue teams [3] and Hinomiyagura under two conditions. One setting (α) is that the points are uniformly distributed over the maps. The other setting (β) is that the points are distributed at center of t he maps.

To make problems clear, no center agents and no refuge is set. Values in upper rows are surviving rates($number\ of\ alive\ agents/P$) and in lower rows are not_burned rates ($B/Bmax$) .

Table 2. Statistical data of wards and simulation results

	statistical data		network properties			number of agents			
ward	area	population	road	node	build.	Civilian	Fire	Amub.	Police
Chikusa	18.24	152,162	5,581	3,711	1,692	142	9	5	10
Higashi	7.72	67,788	2,420	1,690	757	63	7	4	10
Nishi	17.9	142,387	6,430	4,122	1,491	133	9	5	10
Showa	10.93	104,789	3,795	2,456	1,186	98	7	4	10
Mizhuho	11.23	104,690	4,053	2,563	1,062	97	5	3	10
Meitou	19.42	155,836	5,612	3,724	1,556	145	9	5	10

Table 3. Simulation results

	surviving rate				unburned rate			
	Sample		Hinomiyagura		Sample		Hinomiyagura	
ward	α	β	α	β	α	β	α	β
Chikusa	41%	51%	33%	50%	52%	71%	52%	71%
Higashi	35%	48%	58%	45%	15%	52%	74%	53%
Nishi	43%	58%	45%	60%	51%	70%	51%	70%
Showa	24%	40%	45%	42%	13%	51%	57%	54%
Mizuho	21%	46%	22%	43%	7%	60%	7%	60%
Meitou	40%	50%	40%	50%	43%	59%	43%	60%

[3] Agents are included in RoboCup Rescue package.

4.2 Simulation II

Initial positions of fire ignition and civilian locations are important factors for rescue simulations.

Table 4 show the results of three different situations. The first one is that all civilians are on the roads, the middle one is that half of them are on the roads and the other half are in houses, and the last one is that all civilians in the house. The middle one corresponds to daylight hours and the last one corresponds to midnight hours. This situations are created at the third step. These shows that surviving rates at daytime are higher than at night and it follows our common sense.

Table 4. Simulation results

	all agents on roads		half on roads		all in buildings	
ward	surviving	not_burned	surviving	not_burned	surviving	not_burned
Chikusa	99%	99%	77%	99%	58%	97%
Higashi	100%	100%	80%	100%	57%	100%

5 Conclusion

In this paper, we presented our tool kits that creat RoboCup Rescue map files from open public GIS data. These tools are useful to expand Resuce simulation fields to real situations.

Authors appreciate RoboCup Rescue community that provides a fine software environments and organizations that provide GIS data.

References

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Appendix: how to use tools

Tools are made up with three programs. Details are explained in README file.

step 1: conversion to Rescue Format files

This step is to make node.bin and road.bin files. It is straightforward and the specification depends on the format of GIS data that are open to the public. Followins are XML form that Geographical Survey Institute national surveying (Japan) provides.

```
<DoroSetten id='DS23106000001'>
  <point id='PT23106000212'>
    <CRS idref='JGD2000'/>
    <position>492811.4760 126604.4470</position>
  </point>
  <node id='ND23106000001'>
    <geometry idref='PT23106000212'/>
  </node>
</DoroSetten>
:
<DoroKukan id='DK23106000142'>
   :
  <curve id='CV23106000225'>
    <CRS idref='JGD2000'/>
    &lt;segment&gt;
      <controlPoint>492811.4760 126604.4470</controlPoint>
      <controlPoint>492812.3730 126604.3600</controlPoint>
      <interpolation>linear</interpolation>
    &lt;/segment&gt;
  </curve>
  <edge id='EG23106001807'>
    <boundary idref='ND23106000001'/>
    <boundary idref='ND23106000004'/>
    <geometry idref='CV23106000225'/>
  </edge>
</DoroKukan>
```

step 2: generation of building.bin file

Generically, personal properties are not contained in the open GIS data. Data on houses are such personal information. They are key data for disaster simulators, such as fire simulator, collapse simulator and etc. It is necessary to create building.bin files.

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