

3D-GIS Application for Urban Planning based on 3D City Model

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Abstract

In major cities in Japan, various issues have been appeared in urban development projects. Visual presentations are recognized as powerful tools for the project committee to reach a consensus. A 3D-GIS application prototype was developed to visualize the existing state of cities and to perform simulations of district development plan. In this application, the high-resolution 3D city model is introduced, combined with the 2D urban planning database. The Application was developed based on ArcView8 and 3D Analyst with ArcObjects, to analyze and visualize existing buildings, regulations for urban planning and results of simulations.

1. Introduction

With the rapid development of technologies in recent years, such as the laser scanner, the airborne sensor and 3D computer graphics, 3D-GIS has been emerged with reality. However, most of 3D-GIS applications tend to focus on visualization such as walk-through animations or scenic simulations.

The application introduced in this paper was developed as one of prototypes, which were developed to demonstrate usability of 3D-GIS in various fields. The Objectives of the application are :

- Visualize complicated urban planning regulations in the 3D way to be easily understood.
- Compare the existing buildings and the regulations on the 3D city model.
- Simulate the proposed urban development plans.
- Support local governments to reach a consensus with communities and industries.

2. System Overview

The application is composed of three components as described in Figure. 1. 2D-GIS is utilized to view urban planning database, specify target areas and parameters for simulations. 3D-GIS is introduced to visualize the existing state of cities and results of analyses. Also, a CAD software package for building simulations is utilized to simulate allowable height and shape of a planned building.

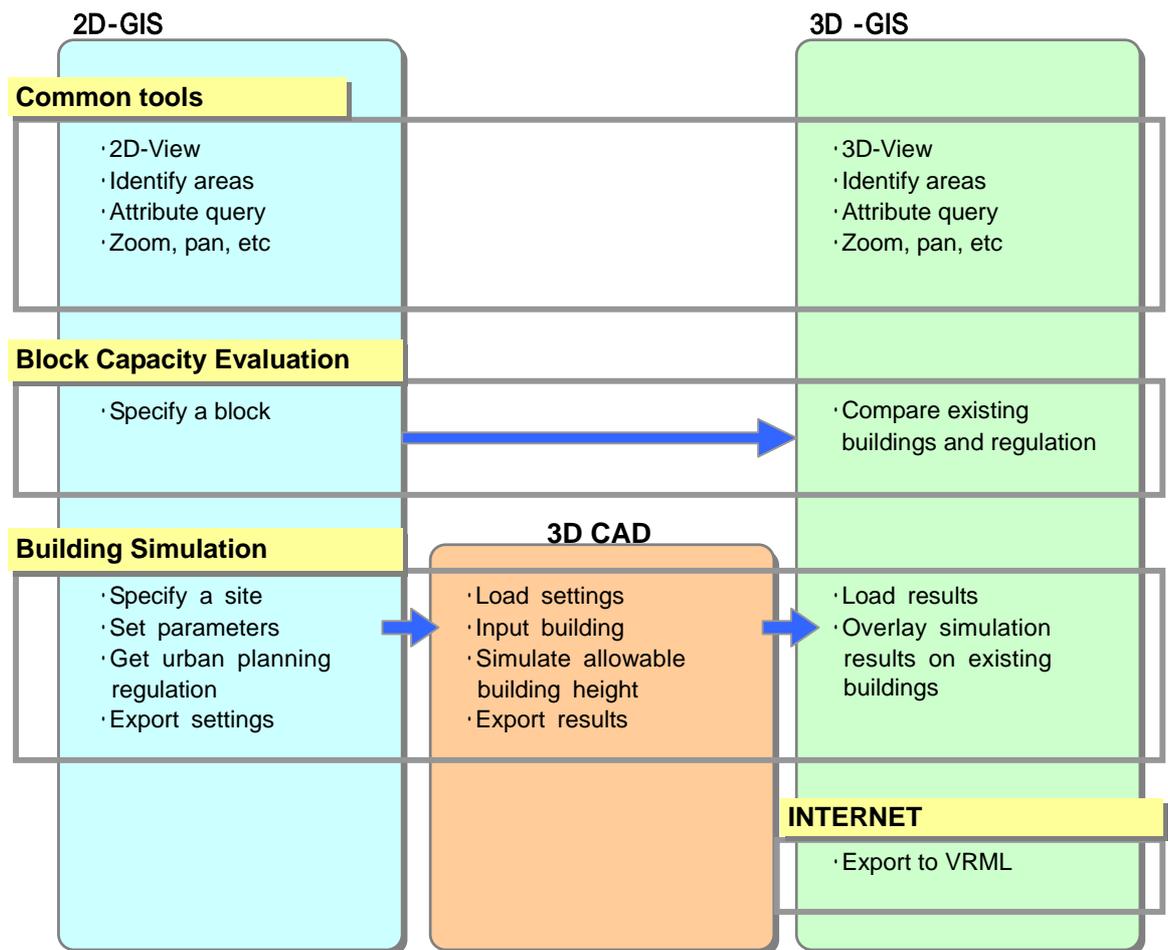


Figure. 1 Structure of the Application

Table 1 shows software packages employed in this project. The application was developed using Visual Basic and ArcObjects components.

Table 1 Employed Package software

Category	Software	Comment
2D-GIS	ArcView8.2 (ArcMap)	
3D GIS	3D Analyst (ArcScene)	
Building Simulation	3D Planner	Japanese only

3. Database

The application is based on the spatial database, which consists of the following three parts.

(1) 3D City Model

3D-Map database employed in the application is a database product distributed in Japan. This database, named MAPCUBE_{TM}, has characteristics as following.

- A Set of high-resolution 3D buildings, landmark objects and terrain model
- With aerial-photo textures for terrain model
- Realistic photo textures for buildings (optional)

In the application developed here, 3D city model is converted to ArcGIS database described in Table 2. 3D building features are converted to 2D polygons with attributes of building height. The terrain model is converted to a GRID dataset. These datasets are compiled on ArcMap and ArcScene.

Table 2. 3D Database

Contents	Description	Attributes	Comments
Building	Polygon features describing Buildings	Elevation Ground Level Building Height Use Floor Area	2D Shapefile
Terrain	Terrain Model		GRID (5m cellsize)

(2) Urban Planning Database

In order to simulate urban development plans, it is necessary to utilize urban planning database including regulations. Table 3 shows urban planning database used in this application.

Table 3 Urban Planning Database

Category	Contents	Attributes used in analyses
Designation	Areas for city planning	
	Urbanization promotion area and urbanization control area	
	Land Use Zoning	Building-to-land ratio, Floor area ratio
	Building Height Control Districts	Maximum and minimum of building height
	High-Use Districts	Maximum and minimum of building-to-area ratio, floor area ratio, minimum of building floor area
	Fireproof and Quasi-fireproof districts	
	Scenic Districts	Maximum of building-to-area ratio, building height
	Area for Developing Car Parking Facilities	
	Port Zone	
	Green Zone Conservation Area	
	Productive Green Area	
	District Planning	Maximum and minimum of building-to-area ratio, floor area ratio, building height
Survey	Building Structure and Use	Floor, floor area, site area
	Land Use	

(3) Base Maps

Table 4 shows base map database used in 2D and 3D View. The map data are compiled in the scale of 1/2500.

Table 4 Base Map Database

Contents	Description
Index	Index map
Road	Roads, Pavements, etc
Governmental Boundary	City boundary, District boundary, etc
Contour	Contour lines
Water	River, Canal, Shoreline, etc
Vegetation	Vegetation
Symbols	Landmark, Vegetation, Objects, etc
Annotation	City name, Building name, etc
Aerial Photograph	Aerial Photograph (Ortho-rectified)

Figure. 4 shows an “Identify” tool in the 3D View. Users can select a building in the 3D view to query information at the selected site, such as land use zoning, building height regulations and so on.

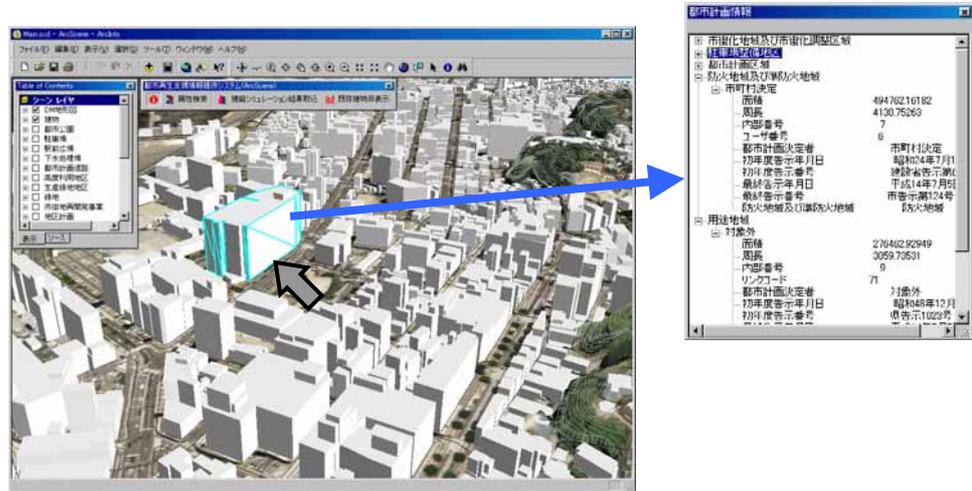


Figure. 4 Identify tool in the 3D view

(3) Evaluate Block Capacity

This application enables users to evaluate the capacity of specified block. Urban planning regulations can be visualized in the 3D view, which control allowable height of buildings in the block. Also, the difference between existing building height and regulations can be computed and visualized. Figure. 5 shows a procedure of simulations.

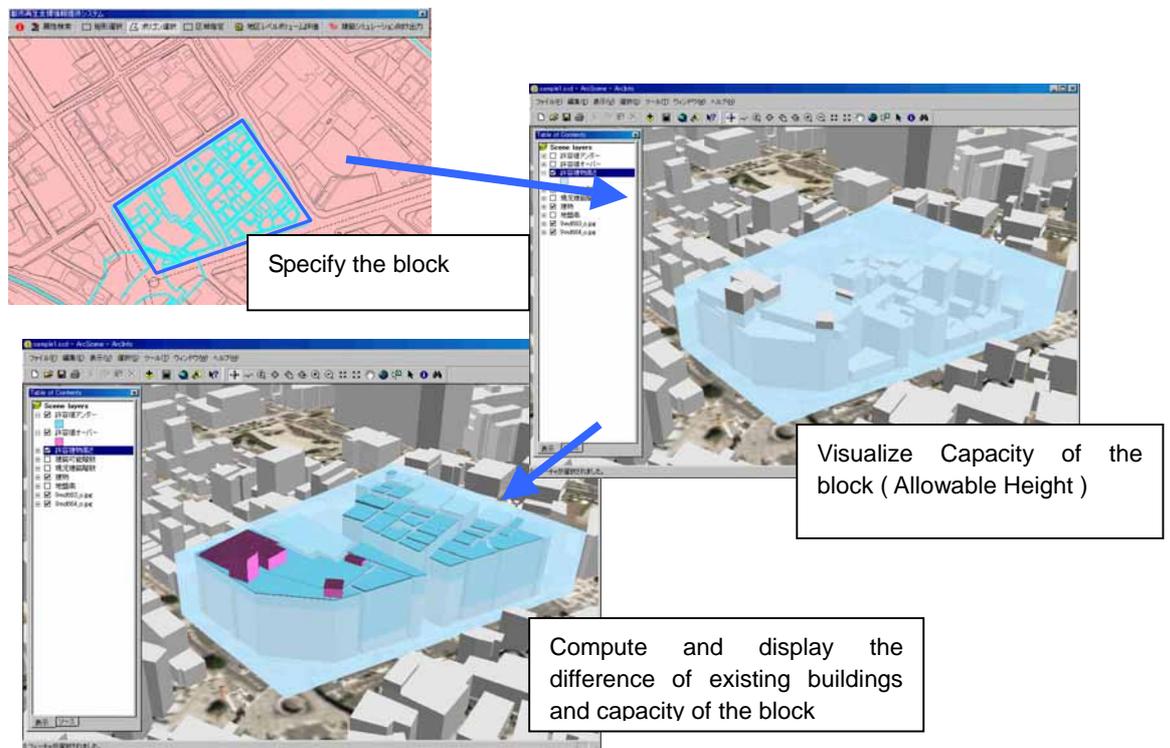


Figure. 5 Evaluate capacity of the block

(4) Building Plan Simulation

Furthermore, this application provides users a method to simulate proposed building plans. First, users specify a site of planned building in the 2D view. The regulation information is obtained from urban planning database. Also, users can specify parameters for simulation, such as surrounding road conditions, floors of the building and system work paths.

Then, a 3D-CAD package, named 3D-Planner, is employed to simulate allowable building height. In 3D-Planner, users pile up small 3D-blocks to make up planned building inside the site specified in the 2D view. Height and shape of the building are controlled automatically based on the regulations obtained from urban planning database.

Finally, the simulated building shape is imported to the 3D view and overlaid on the existing buildings. It enables users to evaluate relationships between the planned building and existing buildings from various viewpoints.

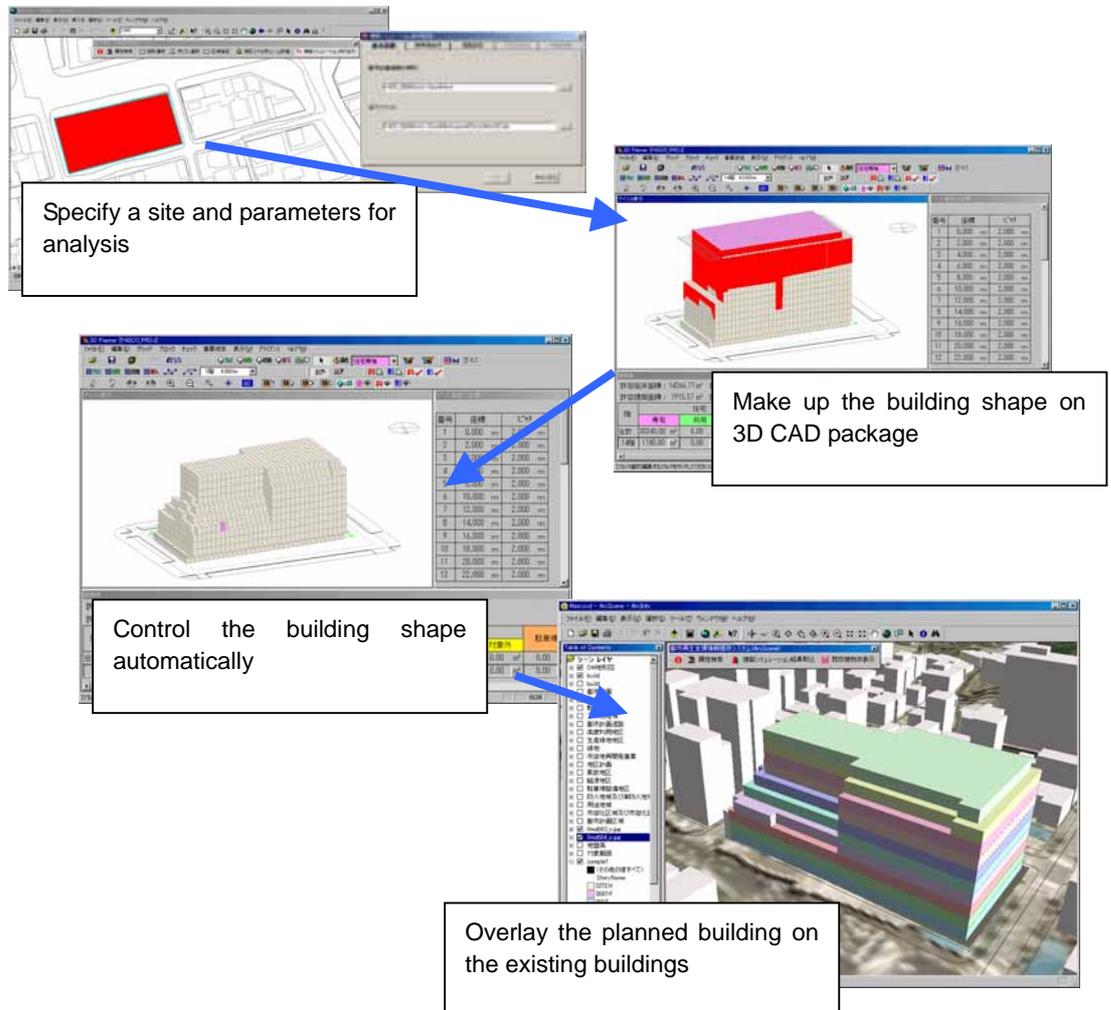


Figure. 6 Building Plan Simulation

(5) Export

The simulated scenes can be exported from ArcScene to VRML format so that planners could publish results of analyses on the Internet (Figure. 7).

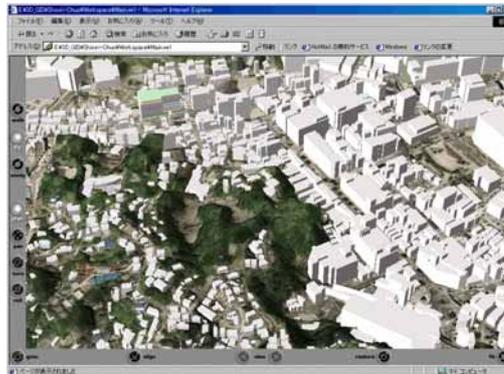


Figure. 7 VRML View

5. Conclusion

A 3D-GIS application was developed in order to evaluate urban space efficiently and to provide information about urban planning to local communities. This application enables users to visualize complicated urban planning information in 3D way, to evaluate allowable capacity of block and to simulate building plans. With visualization and analysis capability, 3D-GIS is considered as a powerful tool to solve various issues which modern cities confront.

Acknowledgement

We would like to deeply thank to the MPHPT(Ministry Of Public Management, Home Affairs, Posts and Telecommunications) in Japan to provide an opportunity to present this paper.

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