Digital Platform for Collaborative Urban Landscape Design using Google Earth

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1 INTRODUCTION

Japanese local authorities have become focus on urban design issues than before along with the enforcement of Landscape Law of Japan in 2005. At the same time, people became aware of the lack of regionality in individual cities and their desire for creating beautiful country.

Urban design is not only the work of assembling design elements for making up aesthetic quality but also the process for creating the livable and sustainable community. Further, design process involves a lot of bodies and citizens, therefore, the common platform is needed to share the urban forms and environmental impacts.

Information technology is expected to encourage visualizing imaginary urban space and invisible environment issues which appear in the design process. Google Earth could be a useful platform for those purposes. It is free, downloadable and easy to navigate virtual urban space. This paper shows an implementation process of Virtual Fukuoka in Google Earth, a seamless digital platform for urban landscape design.

2 SPATIAL DATA COLLECTION

2.1 Case Study Area

A case study is done in Fukuoka City Japan, the eighth largest city, situated in the island of Kyushu, Japan, where the authors' parent research unit has been collecting huge stocks of 2D/3D spatial data for landscape research. They consist of digital maps, digital terrain models, aerial photos, landuse data, ecological maps and others which cover the entire area of the city approximately 329 sq. kms. Fukuoka city faces Genkai Sea to the north and is surrounded on three sides by mountains. Those natural geographic factors contribute to bring city diversified scenic as well as the modern urban landscape of downtown, waterfront and other new development sites in the inner area of the city.

2.2 Maps, Models and Database

2.2.1 2D maps and database

Digital maps from 1/2,500 to 1/25,000 are stored, mostly ESRI shape file format, in GIS system. Large scale base map is originally surveyed by 1/2,500 and layered into boundary line, building footprint, building plot, road and railway line. The existing landuse data which has 15 categories such as residential area, commercial area and others defined by the legal guideline is linked to each building site shown in Fig.1. In addition, other thematic maps such as ecological map, vegetation map, geologic map are drawn as results of specific analysis and field survey, and then stored into GIS.

2.2.2 3D models

Google Earth can show 3D buildings by original setting in Fukuoka City. But those shapes are simply expanding building footprint to the vertical direction with the height of the number of building stories multiplied by uniform floor height. But the building forms are more complicated and the floor heights vary by each building and floor, thus, we use the MAPCUBE data, developed by Pasco, Increment P and CAD Center, Japan.

Mapcube is a set of three dimensional models of the buildings and other structures based on the DSM (Digital Surface Model) derived from LiDAR (Laser imaging detection and ranging) data. Object data of the buildings are stored in the Wavefront OBJ format files and some buildings known as the landmarks in the city have their surface texture stored in the MTL format files. Figure 2 left shows the DSM data of the central Fukuoka city and the right figure shows the 3D buildings on the DTM data.

2.2.3 Other data

MAPCUBE also provides DTM (Digital Terrain Models) in the Wavefront OBJ format. The resolution of DTM data is 2.5m whilst Google Earth has 30m resolution DTM data collected by NASA's STRM (Shuttle

Radar Topographic Mission). The orthographic photo images are scanned by 1/2,500 color and stored in 1,000m x 50m quadrangle unit Tiff format files. Each pixel represents 10cm on the ground. In our field survey, various snapshots of urban landscape are collected and stored in the database. Some snapshots are linked to the GPS location data and the location data is filled in Exif format file.

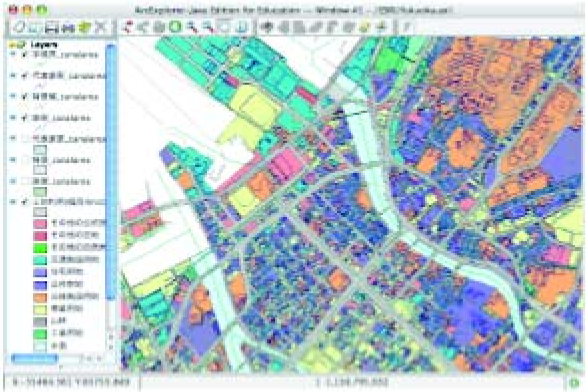

Fig. 1: 2D map colored by landuse category

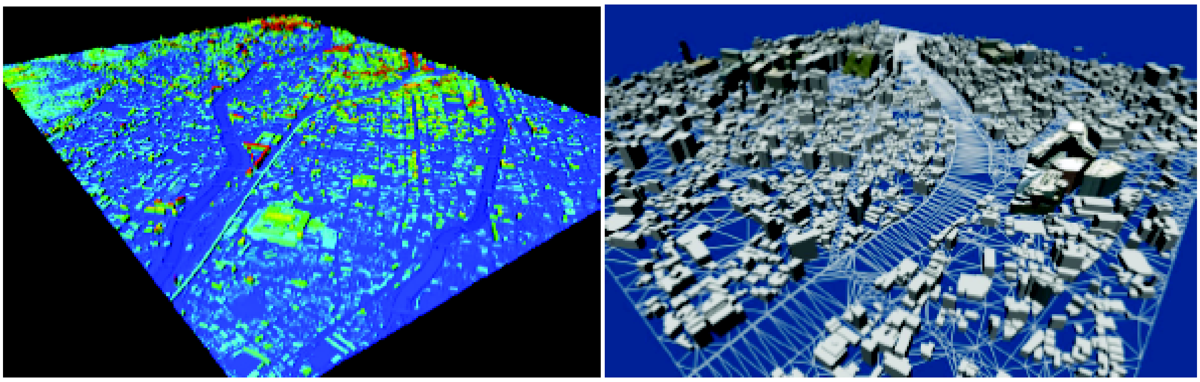

Fig. 2: 3D Models (left: DSM, right: 3D Buildings and terrain model)

3 DATA IMPLEMENTATION PROCESS

3.1 Google Earth

Google Earth is a virtual globe on which the satellite image is mapped provided by Google Inc. It is very easy to navigate the imaginary earth all over the world and its download is counted over a couple hundred million for use in the broad area of interest. It supports KML (Keyhole Markup Language) and COLLADA (Collaborative Data Asset) format, both of which are XML-based languages whose specs are fully disclosed. Therefore, we can make the program to import/export from CG and GIS to Google Earth to. Some of those scripts are already downloadable on the Internet. The performance has been rapidly improving since its first release on May 2005. On June 2006, texture mapping model import is supported and on September 2006, 3D building models are added to major US and Japanese cities.

The reasons that Google Earth is suitable for a platform of collaborative landscape design are:

- It is able to visualize the imaginary of urban space and simulate urban environment on one platform integrating the basic functions of computer graphics, virtual reality and geographic information system.
- It has already millions of users. And that means it is a familiar platform to them
- The performance is rapidly improving and it has wide range of applications.

3.2 Data Conversion

Google Earth is using geodetic coordination system which expresses the location by latitude, longitude and altitude with WGS84 datum. The spatial data of Fukuoka city is mostly using planner cartesian coordinate system mixed with Tokyo datum and WGS84 datum. Therefore, the reprojection and the transform works are expected to overlay those spatial data in Google Earth. After the reprojection and datum shifts, spatial data are converted to KML and COLLADA format files.

KML is an XML-based language for modeling and managing geospatial data such as point, image and polygon in Google Earth. KML file has a .kml extension and KMZ file is a zipped KML files with a .kmz extension. COLLADA is also an XML-based language to make it easy to exchange the data among 3D applications. It is originally developed for making the gaming software by Sony Computer Entertainment Inc., and available for the 3D modeling in Google Earth.

Each landmark building has a dataset of object, UV and texture in OBJ, MTL and BMP format respectively, and other building data is stored by 250m x 250m quadrangle unit in OBJ format file. Self-made Perl scripts are used for converting OBJ/MTL format files to COLLADA format files. GIS data is stored in ESRI Shape file formats with a .shp extension. Export to KML 2.3.4, downloadable program from ESRI Web site, is used for converting SHP files to KML files. Figure 3 shows the diagram of data conversion process to Google Earth.

Fig. 3: Diagram of Data Implementation

3.3 Import and Overlay

3.3.1 Overlay 3D objects

Two images are shown in Figure 4. The Left one is a city wide view and the right one is the image of Tenjin downtown place. Those images are rendering the 3D building models placed in the center with the mountains surrounding the city. Those wide spread land surface and long distant landscape with topographic data can enhance the reality of virtual urban .

Fig. 4: 3D Textured models in Google Earth

3.3.2 Overlay GIS data

Figure 5 (left) is a superimposed image of the landuse data converted from the GIS shown in Fig. 1. Google It is not easy for GIS to display the result extensively in 3D but it can cover the broad area and show imported spatial environmental data easily. Though Google Earth itself does not have the spatial analysis function, these usages help people to understand the physical environment in urban space.

3.3.3 Overlays for landscape design and survey

Figure 5 (right) shows the landscape study on a trial basis to check the key views and vistas to be retained. Three gray fan-shaped polygons are visualizing visible and invisible area from each view point to each observation point respectively. This overlay can be effective for the check of height control of the buildings when used with landuse overlay such as Fig. 5 (left).

GPS locator can trace the route of the field survey and log the location and time in GPX format by certain interval of time according to the moving speed. The time stamp information in the digital photo data is synchronized to GPS log data and the location data is filled into Exif (Exchangeable image file format). Exif file with the location data can be imported on the Google Earth as shown in Fig. 6. Some free software on the Internet is used in this process for linking and importing data.

Fig. 5: Overlay for design survey (left: landuse, right: key views and vista)

Fig. 6: Route of field survey (left) and Snapshot linked to its location (right)

4 TECNICAL AND FUNCTIONAL FEATURES

The following features are confirmed in the data implementation process.

- The total operationality is superior to other 3D systems that the user is often required the operational skill. The navigation in virtual urban space is very easy. User can move, rotate the viewpoint and manage layers and time scale on one window without special skill. This user friendliness is one of the major criteria for the common platform in collaborative urban landscape design.
- The spatial data can be controlled by each object and group in KML scripting. Time management is possible as well. Further, hyperlinks in KML can dynamically connect to the files in remote or local network locations for updating or adding new spatial objects. Those features are effective for the analysis of the change and the comparative study of urban landscape.
- The resolution of the satellite is higher enough but the horidontal accuracy is not enouth. Therefore, we have to lose the accuracy to fit the Google Earth image though we have accurate 3d models scale with the the survey map. Further, the accuracy of the altitude data is not enough for the close up view. More accurate altitude data such as 5m mesh DEM provided by Geographical Survey Institute is worthy of consideration.

- KML or KMZ file should be disclosed for every user if we want to make it usable for them in the collaborative design. But there are several restrictions to deliver spatial data which is protected by copyright.
- The hardware performance is slowing down when the large size high resolution image is overlayed. The hierarchical grouping and adequate nesting is needed in KML programming.

5 CONCLUSION

It is confirmed that Virtual Fukuoka has a sufficient possibility to be a powerful and easy to use platform for urban landscape design. User can overlay, switch and animate various spatial features along with the navigation in virtual urban space. Another case study is going on in Tokyo with some improvement of this methodology along with Urban Renaissance model research supported by the Cabinet.

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