MULTI-TEMPORAL VIRTUAL 3D CAMPUS INTEGRATED WITH HISTORIC GIS DATA

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ABSTRACT: 3D cyber city is a major development in Geomatics and there is a wide range of applications such as land management, urban planning and disaster-prevention. In addition to the functionality of visualization, 3D building models with information-based attributes can provide diversified applications. The study aims at presenting the historic development of National Central University of Taiwan from 2D to 3D changes combing multi-temporal aerial images and 3D building models. Within the virtual campus, attributes and spatial information such as parking and daily-life facilities management can be added into a spatial information and virtual reality platform. Such a virtual environment not only can display a digital campus but also facilitate variable applications. For specific building model reconstruction, the developed techniques can reach high level of detail including the appearance and interior structures. In addition, new buildings can be pre-visualized and simulated in the virtual system and allow the change of design before the real construction. With geospatial data integration and management the 3D virtual campus provides the function to overview the whole campus and future development through the internet and digital devices. Furthermore, the developed virtual system can be used as a promotion and management platform within the campus.

1. BACKGROUNDS AND MOTIVATION

Text, photos, course data and additional information are the main sources to introduce the contents of a campus website, but the information is insufficient to fully overview the characters and backgrounds of a modern university. With the development and improvement of remote sensing technology and the promotion of smart cities, geography information is no longer manipulated only in 2D platforms but progressed into 3D presentations. Current 3D cyber city programs such as Microsoft Bing Map (Bing Map, 2010) and Google Earth (Google Earth, 2010) are able to integrate digital terrain models, satellite and aerial images, 3D building models and related geography information to serve as an integrated 3D spatial information platform to publics. A GIS system with 2D maps (raster and vector data), geo-information data and visualization functionality has the ability of spatial interaction and analysis (Andrienko and Gitis, 2003). Based on these techniques, a simulated 3D campus can be constructed through the integration of multiyear (and multi-temporal) aerial imagery, building information and 3D building models while displaying on computer systems. Visitors can realize the campus development and history by overviewing the integrated 3D campus and an interacted environment can be used online. Using the concept of a virtual 3D campus, facilities management can also be carried out more effectively, and related costs can be reduced while raising the administration.

2. MATERIALS AND RESULTS

This study is mainly divided into two sections, including (1) data collection and format manipulation and (2) virtual system construction. A proposed scheme of this study is shown as Figure 1.

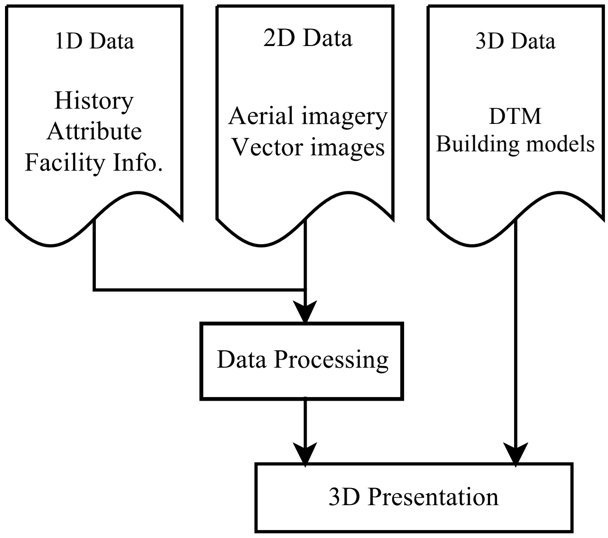

Figure1. Data processing and manipulations

2.1 Data Collection and Processing

Spatial information can be separated into several types and data pre-processing is to integrate history information, aerial images, 3D building models and associated attributes on their corresponding locations. Spatial information presentation in virtual environments is an important medium to introduce its contents. For example, historical information can be provided in dialogs; building attributes can be attached onto 3D models and consulted directly through the system. Similarly, campus facilities are displayed using diversified icons within the virtual environment. For building models reconstruction, CAD building data can be turned into 3D models or using geometry features to form 3D building models (Gruen and Wang, 1988). Once 3D building models are reconstructed, textures can be attached onto the building surfaces in order to provide a more realistic look and feel and to enable virtual campus tour or other applications. Because there are many kinds of data in this system, a specific coordinate system is necessary to integrate different spatial information for further management and usages. For this purpose, WGS84 is used in this study as the universal coordinate system.

2.2 Virtual System Construction

Data classification is adapted to separate variable years of campus development via multi-temporal aerial images and building models in order to increase the efficiency of spatial applications and analysis of different periods. In addition, the capacity of virtual system operation can be improved if diversified spatial and non-spatial information are well-classified and managed. To provide a sense of age for historical data, facades and appearances of building models are displayed as grey level images for those before 2000.

3. EXPERIMENTAL RESULTS

This study provides an example of digital National Central University campus using multiyear and multi-temporal aerial imagery with the integration of LOD2, LOD3 and LOD4 building models. In addition, geometric and non-geometric attributes are attached onto the building models such that facilities and properties can be well managed through a digital campus. Results of this study are separated into two sections, mainly (1) presentation of campus historical culture and (2) simulations of future development and planning.

3.1 Campus Historical Culture

In order to present a highly realistic digital campus, facade textures and ortho-rectified images are generated to improve the appearances of building models. A template campus scene of 1974 is displayed as Figure 2 and it is easy to realize the status and development of school buildings. Meanwhile, grey-level building models of the era are displayed to proved the historical sense of the campus at the era. Figure 3 is the current status of this campus with colored aerial photograph and realistic 3D building modes. Figure 4 is an example of LOD3 building models and Figure 5 reaches LOD4 building models with interior constructions.

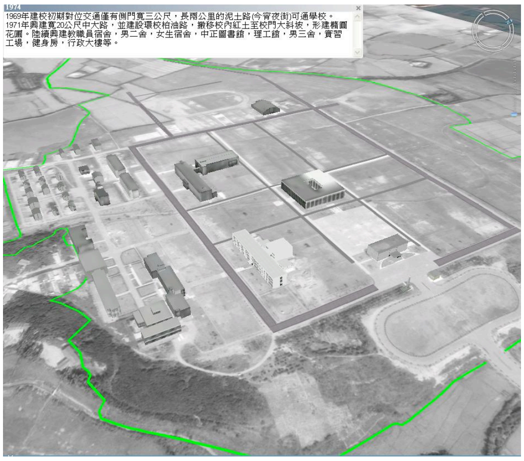

Figure2. NCU campus scenery of 1974

Figure3. Present NCU campus

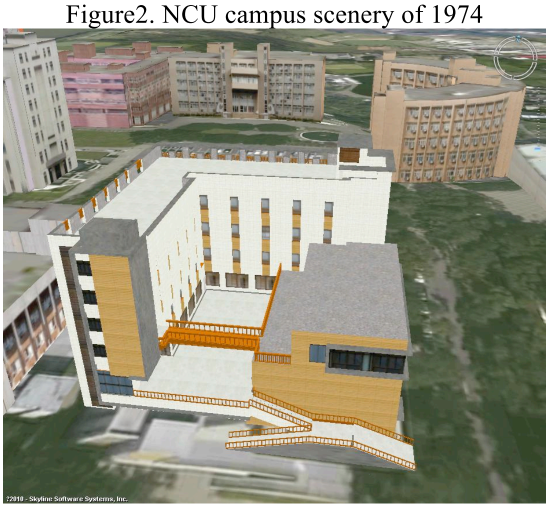

Figure4. LOD3 building models

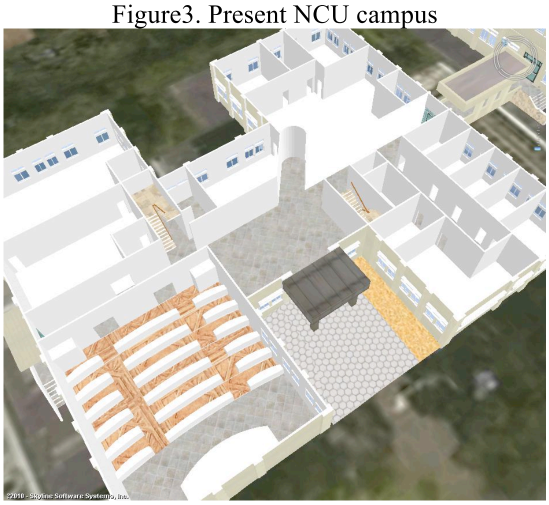

Figure5. LOD4 building models

3.2 Attribute attachment and future planning

In addition to the displaying of building models, spatial and non-spatial attributes presentation is one the targets of this digital campus construction. Figure 6 is an instance of vending machine query function within the campus; the result displaying its exact location and available merchandise for students and other users. Wifi hot-spot is a popular query item in a digital campus system and it provides the functionality of internet access while they can be geo-visualized in a virtual campus as displayed in Figure 7. A simulation of future building construction can be achieved using 3D digital campus from its stage of planning to completion as displayed in Figure 8 and Figure 9.

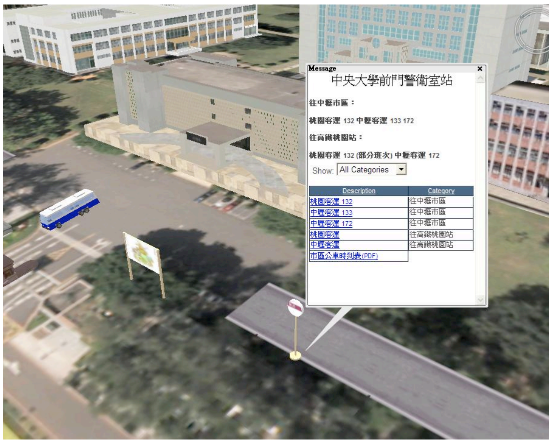

Figure6. A vending machine and attributes

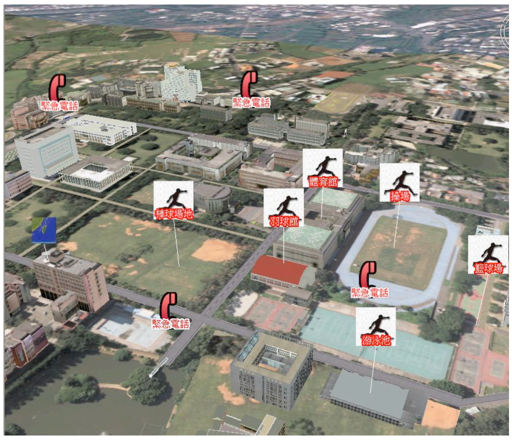

Figure7、Wifi hot-spots in the digital campus

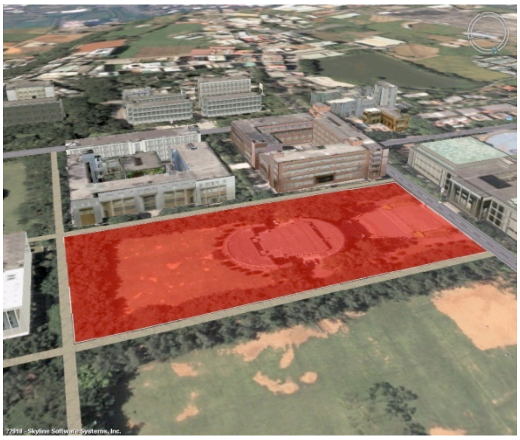

Figure8. Area of building construction

Figure9. Simulation of a complete building

In addition to above examples, functionalities of classroom reservation and property maintenance are also provided in this virtual system and these functionalities are used by faculty members, students, and administrative staff daily.

4. CONCLUSION

This study is focudsed on the constriction of a multi-temporal virtual 3D campus regarding its historical development and can increase the user familiarity toward the campus. A digital campus construction should be processed in a serious manner and strengthen the completion of building models and their corresponding attributes and information. In general, the developed virtual 3D campus not only can be used for multi-temporal presentation of a university; it can also provide useful functionalities to support different users in a university campus. This virtual campus can be viewed as a beginning toward smart campus application and analysis through geo-spatial data and system integration.

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