

Three-dimensional GIS approach for management of assets

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Abstract. Assets play an important role in human life, especially to an organization. Organizations strive and put more effort to improve its operation and assets management. The development of GIS technology has become a powerful tool in management as it is able to provide a complete inventory for managing assets with location-based information. Spatial information is one of the requirements in decision making in various areas, including asset management in the buildings. This paper describes a 3D GIS approach for management of assets. An asset management system was developed by integrating GIS concept and 3D model assets. The purposes of 3D visualization to manage assets are to facilitate the analysis and understanding in the complex environment. Behind the 3D model of assets is a database to store the asset information. A user-friendly interface was also designed for more easier to operate the application. In the application developed, location of each individual asset can be easily tracked according to the referring spatial information and 3D viewing. The 3D GIS approach described in this paper is certainly would be useful in asset management. Systematic management of assets can be carried out and this will lead to less-time consuming and cost-effective. The results in this paper will show a new approach to improve asset management.

1. Introduction

Geographic Information System (GIS) is a multi-task tool. It is designed to store, manipulate, analyze and output map-based or spatial information [1]. GIS allows users to handle spatial data in supports of planning, management, maintenance, and making decision. In the past decade, GIS is growing rapidly and three-dimension (3D) is getting more familiar. Hence, there is an increasing desirability for enhanced visualization of the 3D description of spatial data for various applications.

There are many tools and techniques that are used to manage assets efficiently. GIS has been developed for many years. In recent years, GIS becomes a tool for facilities or assets management (FM/AM) where the location of distribution assets can be easily identified and tracked.

The GIS data can be presented by digital images, vector data, tabular information and virtual reality. The motivation for exploring 3D GIS applications for asset management is not only to provide an approximate real-world model but also to produce virtual models that can effectively help in making decision for planning and maintenance work of assets. Furthermore, GIS with 3D visualization also provide additional dimension that can help in determining the approximation of space.

This study is conducted in a computer laboratory, named GIS Lab 1, which is located at block B08, Faculty of Geoinformation and Real Estate (FGRE), Universiti Teknologi Malaysia (UTM). The computer laboratory used in this study is shown in figure 1.

In this paper, we aim to present a developed asset management application with 3D model assets. This application is integrating the potential of GIS in capturing, storing, updating, retrieving, and displaying the assets to facilitate the database management. This paper is divided into 5 sections. Following by introduction, a review on GIS for asset management is discussed in section 2. Methodology and procedures in developing the application is discussed in section 3. The

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implementation of developed application and results are presented in section 4. Lastly, conclusions and suggestions are also presented.



Figure 1. Location of study area (left) and inside the GIS Lab 1 (right).

2. GIS in asset management

Asset management covers a wide field. There are various definitions for asset management has been proposed from different point of view. Asset management can be defined as the process of lifecycle optimization of an asset to perform standards in a safe and environmentally manner through smart planning, investment, maintenance, refurbishment, and replacement [2]. Good asset management should be able to minimize long-term asset costs and also ensure the reliability and productivity of assets.

On the other hand, asset management was defined by Nemmers [3] and Dewan [4], as a systematic process for maintaining, upgrading and operating physical assets in a cost-effective way. The goal of asset management is to develop a system that has ready access to organization's resources as well as its assets and facilities' current and future performance by decision-makers.

From the point of view of Dobos and Steed [5], storage and tracking are two main tasks in asset management. Storage would typically refer to the named files storing on a file system while tracking refer to querying the database to get a set of assets based on the file names stored on a file system.

As GIS become ubiquitous in the past decades, many organizations started using GIS in managing assets and facilities, from large-scale to small-scale objects. The main reason of integrating asset management and GIS is that GIS offers opportunities to streamline organization processes through visualizing, sharing, analyzing and monitoring asset data. These processes are not able to perform with the traditional tabular data, graphs and charts.

2.1 Spatial database

Geographic information system (GIS) is a computer-based information system dealing with geographical data. In GIS, spatial database is important to integrate tabular data and spatial data. Tabular data records all the information in table format. While spatial data are typically referred to spatial related data or geographic locations. The integration of two elements becomes a powerful tool in planning and management. GIS manages asset information by storing, managing, and maintaining asset records. Location information is always essential in asset management because everything about assets can be measured, tracked and condition monitored efficiently.

2.2 Locating asset

Location is an important element of objects, especially in an complexity indoor environment. It is a time-consuming task when need to find assets in the unfamiliar environmnet or roomy space. Becerik-Garber et al. [6] also agreed that locating assets is a repetitive, time-consuming and labour-consuming task for repair technician or asset manager, especially during an emergency. Locating assets also becomes significant when newly assigned personnel responsible for the assets. GIS role in asset management enables the assets to be located and tracked using location mapping and query function. As to have a more accurate of locating assets, spatial database is important to be updated frequently.

2.3 Visualization for asset management

In recent years, 3D visualization of GIS-based applications has been researched and studied by many researchers [7, 8, 9]. Visualization is one of the important elements for the GIS requirement. With the 3D graphical interface, it is able to attach colour, material texture and location about the assets [6].

3D visualization not only for a nice visual to users, but also represents the relationship between the spaces and could be used to plan the placement of asset into a space. Moreover, the navigating and walkthrough can be created for presentation. High visual (3D) between map objects and real world objects also allows users to recognize certain objects easily.

3. Methodology

This section describes the methodology that involves in managing data and the process of developing an application. Figure 2 illustrates the workflow of the application development.

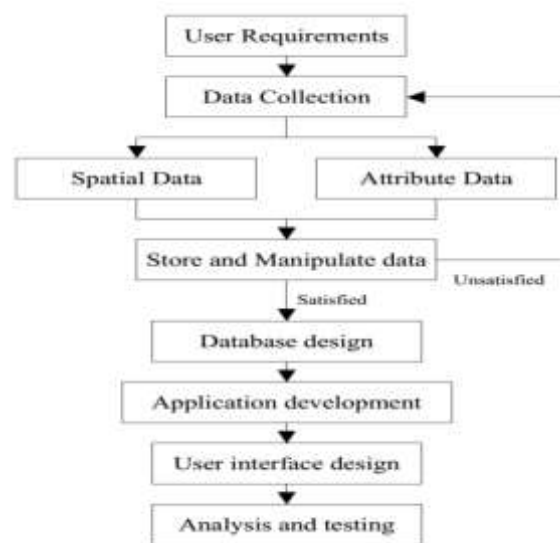


Figure 2. Application development flowchart.

3.1 Data collection

Before started to collect data, interview has been conducted with asset manager to obtain the user requirements and suggestions for the application. The study to be chosen in this research is a computer laboratory, called GIS Lab 1 (figure 1). In this study, data was categorized into: (1) spatial data and (2) attribute data. Spatial data is referred to 3D model of assets in the computer lab and attribute data is the description and information for each asset recorded in tabular form.

As spatial data to be used in this research is 3D model of assets, terrestrial laser scanning technology was used for the rapid 3D data capture. A dense point cloud produced from the terrestrial laser scanner, Leica ScanStation C10. Leica Cyclone software was used for the pre-processing of the point cloud data. The pre-processing stage involves registration of point cloud data and noise filtering. After the pre-processing of point cloud, it was ready to construct the 3D models based on the point cloud in SketchUp software. After the 3D model was completed, it was exported and prepared in Virtual Reality Modelling Language (VRML) format (*.wrl). VRML format is a standard 3D file format that used to display 3D models on the web.

In this research, attribute data was referred to the description about the assets. The data provided by asset manager was incomplete and in the hardcopy format. Thus, the data have to be converted into digital records and complete the blank data fields. The attribute data of assets was stored in a database in Microsoft Access.

3.2 Database design

After having spatial and attribute data, database was developed for storing these data. Database design must satisfy user requirements and a good application or system must fulfil user demands. In other words, database design stage is a critical part towards the success of an application.

In an application, database must be completed with basic information to allow users to quickly search the components they need [10]. In this application, basic information about the asset including asset ID, asset type, registration number, brief description and link to 3D model of asset. This application needs to incorporate all asset information into one database. The database enables the application to retrieve the asset information through SQL command. Figure 3 shows the components in the database.

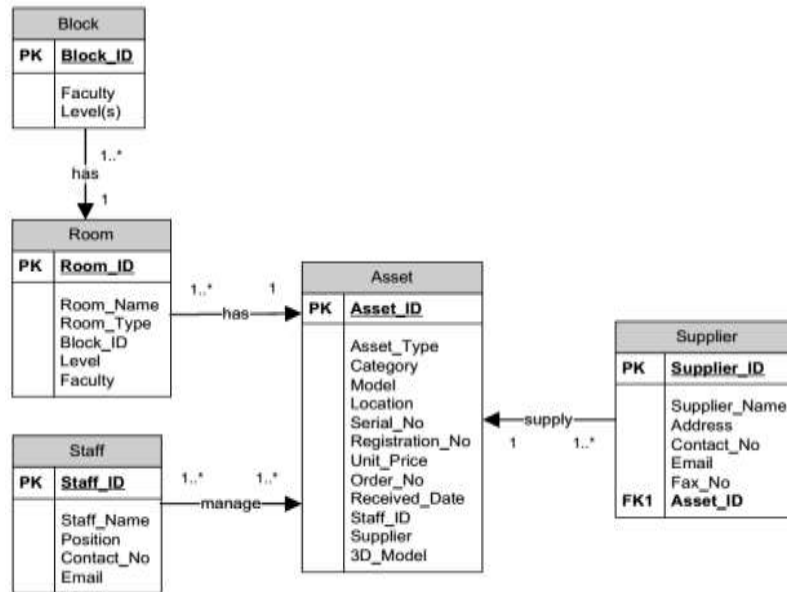


Figure 3. Entity-relationship (ER)-diagram of the database.

3.3 Application development

In this research, the application is developed as a stand-alone desktop-based application using Visual Basic (VB) 6.0 and Microsoft Access. The core processes of the application are the connection between database in Microsoft Access to Visual Basic and Visual Basic to 3D models (VRML format). Some coding was written in Visual Basic to access Microsoft Access database and to display 3D asset models on the user interface.

3.4 User interface design

A user interface is another important element in an application. A good user interface provides a “user-friendly” experience and allows users to interact with the application in natural and intuitive way. In this research, the application user interface was designed and customized by using Visual Basic 6.0. A simple user interface was designed so that it is friendly to use.

From the user interface, there are mainly divided into three divisions: upper-left, lower-left and right (figure 4). The upper-left part was designed for the assets query function; while the lower-left part is to show the result and asset information from the search. The right division was designed as a viewer to display the 3D models for visualization and guidance to the selected asset.

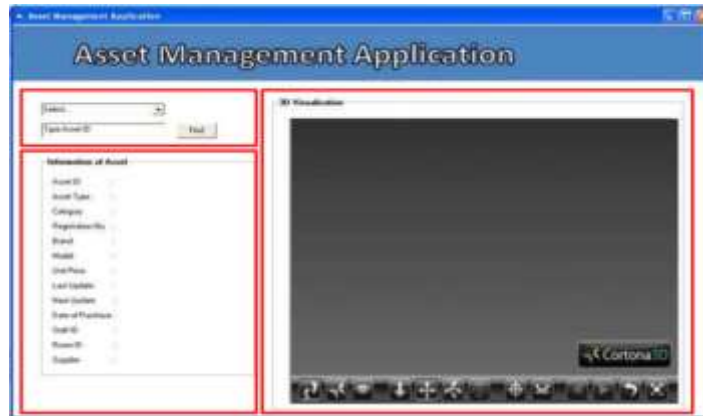


Figure 4. User interface designed for the application.

4. Implementation and results

The asset management application has been developed with the integration of GIS and 3D visualization. User can use this application to query assets within the computer lab.

4.1. Spatial query

The query function is an essential tool in an application. A powerful search function allows users to quickly find the components they need. The application provides two search options: (1) search by Asset ID and (2) search by Registration No. Either one from the search options, it will go through the database to find the matched attribute data. The matched information of asset will display its complete information for the asset.

The query function allows users to find the asset quickly and easily. The query result also includes model asset view in the 3D model viewer.

4.2. 3D model viewer

The 3D model viewer is a VRML viewer called Cortona3D. It is able to display VRML format of 3D asset model. The 3D viewer was designed to display 3D asset model from the query result. As from the query result, an individual asset will be highlighted in the viewer so that users can see where the asset is placed in the computer lab.

The query result will highlight the asset model in the 3D model viewer and the show the details of the selected asset (figure 5a and 5b).



(a) Asset query by Asset ID

(b) Asset query by Registration number

Figure 5. Query result and the selected asset were highlighted in the 3D model viewer.

5. Conclusions and suggestions

This study has successfully developed a stand-alone desktop-based application. It integrates visualization and database approach for asset management work. This application can help in managing asset such as asset tracking, monitoring, and ease of database updating. However,

maintenance of database is important in asset management in order to work more efficient and effective with the application.

The developed application manage to display the 3D visualize model with attribute data. Yet, this application still has a lot of improvements in the future. More functions can be added to the application such as database maintenance operation, measurement tool for 3D models, identify asset from 3D models and 3D model editing. This application is also possible to develop as a web-based application in the future for more effective management in asset management group.

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