

The design of bicycle rental system based on Web-based GIS

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Abstract: This paper designs the Bicycle Rental System (BRS) based on the Web-based GIS to cope with the serious environment, energy consumption, congestion, and space shortage problems. The combination of Web-based Geographic Information System and Bicycle Rental System has many advantages, which make it user-friendly, cheap, dynamic, accessible etc. This passage, in the first place, presents a brief introduction of BRS, including the function and the goal of the system. Then the passage demonstrate the data design and management of BRS in detail, including input data and preprocessing, database design and management, metadata management. Then the passage shows the framework and mechanisms of user layer and operator layer of Bicycle Rental System.

Keywords: Web-based GIS, Bicycle Rental System (BRS), Data, Database

1. Introduction

This paper presents rational design for the development of bicycle rental system in Beijing, which has been popularized in the 2008 but later disappear because of technical and operational problems. With the application of Web-based technology, the users are entitled with easy access to the information with sufficient and real-time information, visual interaction in great convenience.

The goals and functions of this BRS are to:

- 1) Create a bicycle-rental-network in Beijing, which makes it convenient and user-friendly for users to do rental and return business at any rental station.
- 2) Provide more comprehensive and humanized services to satisfy the needs of users. Rental stations is required to provide public and information services such as information inquiries, distance measurement, route query function, or bike maintenance, thus improving the utilization and approvals of the bicycle rental business, and, to some extent, alleviate the congestion

problems in the city

3) Cooperate with traffic card, which has been used in the city transportation. Therefore, people will be more familiar with this kind of service and express more acceptances.

4) Cooperate with a specialized map website, such as Google map. And specially design a function to provide the detail information of bicycle rental business, which can improve the popularization of bicycle rental.

5) Accurately record the conditions of the bicycle by Geographic Information System. And more importantly, repair those in need in time, which can lower the loss of the operation company.

6) Accurately locate the position of bicycle by GIS and solve the problem of stolen, which occur frequently in the business in Beijing.

7) To advertise on the bicycles as a flowing advertisement. In this way, the operation company can obtain more profits and lower the rental fees of bicycle rental.

8) Provide real-time spatial and non-spatial data to track the change of information and other statistics, such as the dynamic information of the bicycle or the new buildings or change in transportation schedule etc.

2. Data Design and management

2.1. Input data and preprocessing

The database design for the Bicycle Rental System should be accomplished by three main stages as fig.2. The data acquired in the data acquisition period include the spatial information, shown in the tab.1, and spatial properties. Spatial database of geographic data involves the bicycle rental station, bus station, commercial surroundings, municipal surroundings bike maintenance station etc. The property database contains the temporal and thematic attributes of the geographic entities. The required temporal attributes are the detail information of the geographical objects listed above. Thematic attributes are other types of attributes of objects that are neither spatial nor temporal. The thematic attributes were tabulated and kept in MS Access (Microsoft Access, 2003) environment (Şalap, 2009).

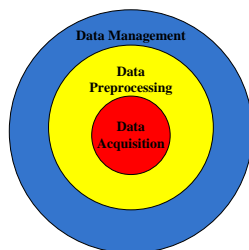


Fig. 1: Three stages of the database design.

Tab. 1: Geographical entities and the database.

Geographical factors	Database	Data clusters
Bicycle	Bicycle	Point datasets
Bicycle rental station	Bicycle rental stations	Point datasets
Bicycle repair station	Bicycle repair stations	Point datasets
Subway station	Subway stations	Point datasets
Bus station	Bus stations	Point datasets
Tourism spot	Tourism spots	Point datasets
Commercial facility	Commercial facilities	Point datasets
Municipal Infrastructure	Municipal Infrastructures	Point database
Bicycle lane	Bicycle lanes	Line datasets
Subway route	Subway routes	Line datasets
Bus route	Bus routes	Line datasets
Main Building	Main building	Area datasets

For example, for the bicycle rental station, the property of it include the name and number of the station, the total number of the bicycles, the operation time, the condition of the bicycles, the tourism information surrounding the station, subway and bus station surrounding it, the commercial facilities etc. The table below is an example of certain geographic entity and its attributes.

Tab. 2: The Attributes of the data of bicycle rental system.

Name	Type	Length
The number of Bicycle Rental Stations	Int	4
The name of Bicycle Rental Stations	char	12
The telephone number of Bicycle Rental Stations	Int	12
The address of Bicycle Rental Stations	char	48
The image of Bicycle Rental Stations	Image	16
The operation time of Bicycle Rental Stations	char	12
The information of bicycles of Bicycle Rental Stations	int	8
The number of usable bicycles	int	8
the basic introduction of Bicycle Rental Stations	text	16
Remarks	text	16

2.2. Database design and management

The database management system, combining a database and a management system, handles four key components which play crucial roles in Web-based GIS because of the always-changing information of BRS, especially the

dynamic information. The four parts are retrieval, update, and visualization of required information (Wang et al., 2009; Chen & Chen, 2011). Database design and management for the BRS can be achieved in several stages. At first, the strategy of the BRS is design to incorporate all the data in a clear structure, which requires the information collected in the former stage. Database management was performed using a computer based management system in MS Access environment by building the main frames of the system. Due to the essentiality of the flexibility for resizing and modification of the database management system, the database should be constructed on a relational structure by eliminating poor and unqualified data element. The developed database schema, consisting of entities and attributes, was illustrated using unified modeling language (UML) (Su, 2000).

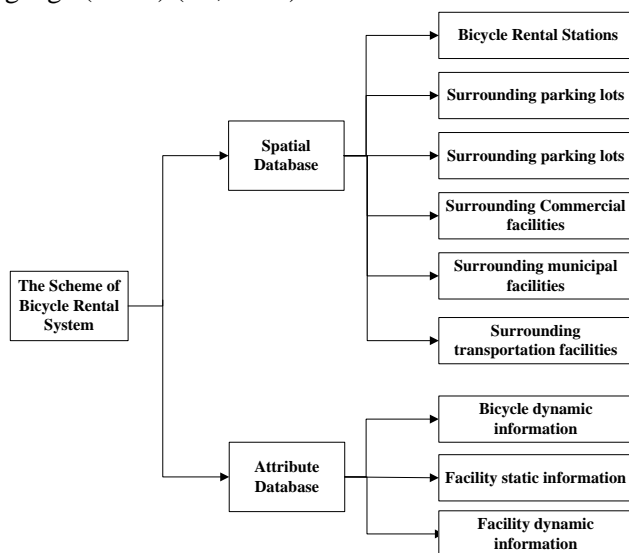


Fig. 2: The Scheme database of BRS.

2.3. Metadata management

Metadata can be defined as the data about data and its management can serve a critical role for accountability and liability in geospatial data management (Anderson, 2003; Wang, 2009). A geospatial metadata record includes core library catalog elements: title, abstract, and publication data; geographic elements: geographic extent and projection information; and database elements: attribute label definitions and attributes domain values (Hall, 2008; Wayne, 2005), all of which are stored in MapInfo.tab file with no less than zero keys, each of which representing a different information category. MapInfo Professional establishes metadata to manage the transactions between MapInfo

Professional and server database, the most important of which are connection string and query built from the program (Chen, 2007).

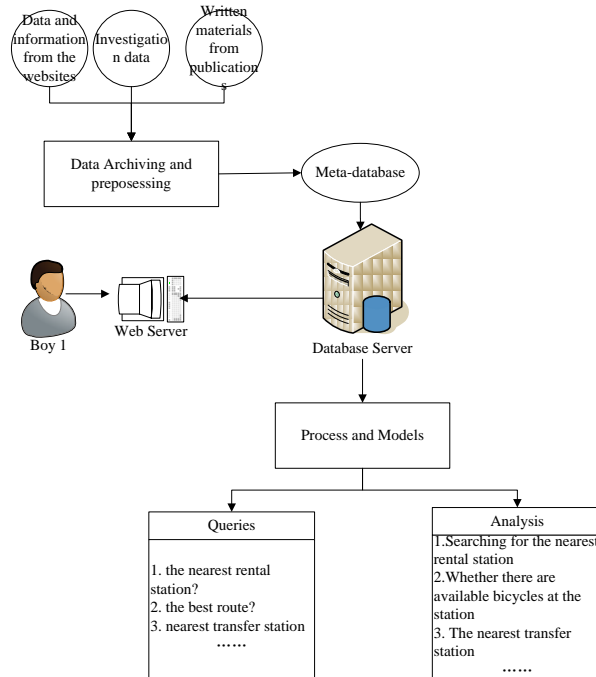


Fig. 3: The mechanism between users and operators.

3. Framework of BRS and Module Analysis

Design of the database was essentially followed by data organizing at two layers, which are user layer and operation layer. This is a general form of data framework that can be applied to any Bicycle Rental System everywhere in the world. However in this study, the entities, attributes, input data, and the relationships above are defined so that the requirements of the BRS could be specified (Chen, 2012).

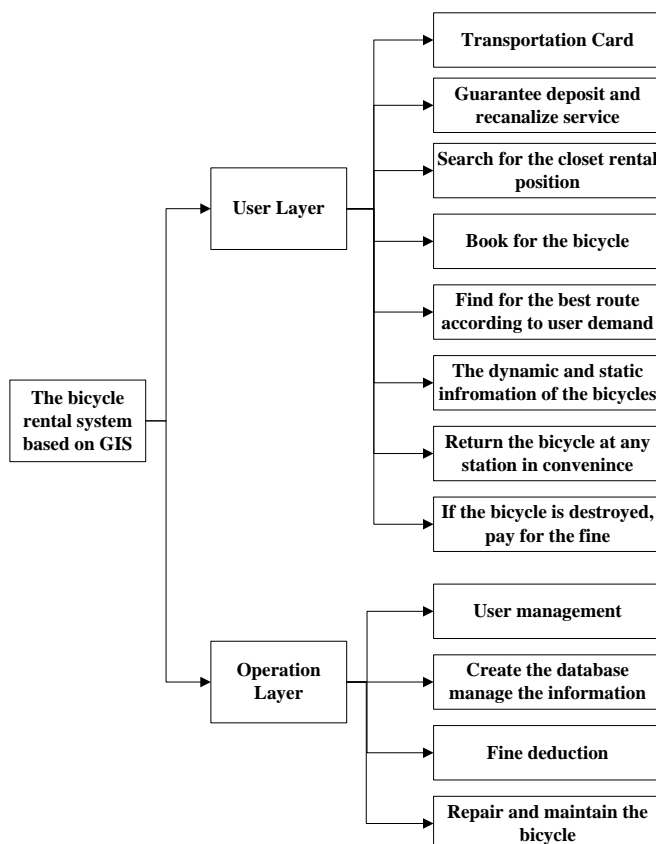


Fig. 4: Framework of BRS.

After establishing the framework of Bicycle Rental System, the next step is module analysis, a key process in the development of BRS. Module Analysis is a process which describes the system requirements and emotional needs and then extracts the function to be achieved., which is a key process in the development of the system (Wei, 2011). The fundamental purpose of module analysis is to put forward (Tang, 2007; Wan et al., 2012) the demand to establish an understanding and communication mechanisms between operators and users. This Mechanism describes the needs of the GIS-based BRS potential users, offering them with the service they need, such as the rental situation, optimal route, facility information etc.

4. Conclusion

This paper firstly brings up the design of Bicycle Rental System (BRS) to keep pace with the increasingly serious problem facing numerous big cites in

environment and transportation. To improve the popularity of this system, web-based GIS plays a great role in making the system more user-friendly and accessible. This passage carefully demonstrates the database of this system, including the preprocessing of input data, database design, metadata management. Moreover, with the basis of the former design, the paper further presents the framework of the system and the mechanisms between users and operators. The further study of this paper is to realize the system with user-friendly software and make it suitable to many cities globally.

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