LBS BASED DIGITAL MEASUABLE IMAGE

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ABSTRACT:

Digital Earth is a visionary concept and outlines a charming prospect for the public. This paper starts from the concept and technologies of Digital Earth and analyzes the architecture of geo-spatial information services of Digital Earth according to the developing trend of requirements for geo-spatial information services. As a promising prospect for Digital Earth, VisionCruiser™ is introduced and its working principle is given in detail. Through analyzing how VisionCruiser™ achieve the four functions of Digital Earth including searchable, visuable, measurable and minable, the conclusion that VisionCruiser™ can satisfy the need of Digital Earth is testified.

1. INTRODUCTION

Digital Earth is a visionary concept, popularized by former US Vice President Al Gore, for the virtual and 3-D representation of the Earth that is spatially referenced and interconnected with digital knowledge archives from around the planet with vast amounts of scientific, natural, and cultural information to describe and understand the Earth, its systems, and human activities.

Digital Earth represents a rich convergence of technological advance, active visionaries and recognition of the paramount need for humans to better understand the Earth. And the industry pioneers who lead the 3D Earth visualization software will present their corporate philosophies and investments for building a true Digital Earth.

Agency leaders from NOAA, NASA, and the United Nations have defined the governance aspects of programs that are helping evolve the Digital Earth Vision.

Digital Earth relates to such supporting technologies as scientific calculating, mass storage, remote sensing, wide-band network, inter-operability and Meta data. Virtual Reality, Geographical Information System (GIS) and Internet are three foundations of Digital Earth. That is to say, in the first place Digital Earth is a virtual reality system that makes people feel to be personally on the scene. In the next place, Digital Earth organizes vast amounts of geo-spatial information through GIS. At the same time a global information network is established to realize resources sharing.

Three layers are necessary for the construction of Digital Earth, as shown in Figure 1. The first layer is Information Infrastructure composed of Space-Based Information Network and Internet. The next layer is Spatial Information Infrastructure. The third layer is thematic data including the filed of humanities, geography and economy and corresponding mining tool.

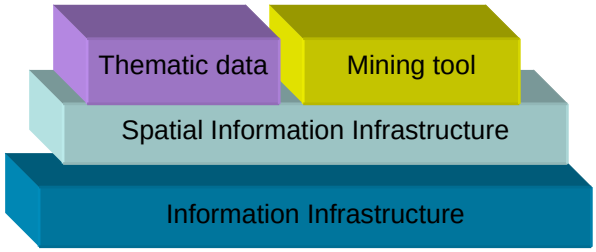


Figure 1 three layers for the construction of Digital Earth

2. METHODLOGY

2.1 The four functions of Digital Earth

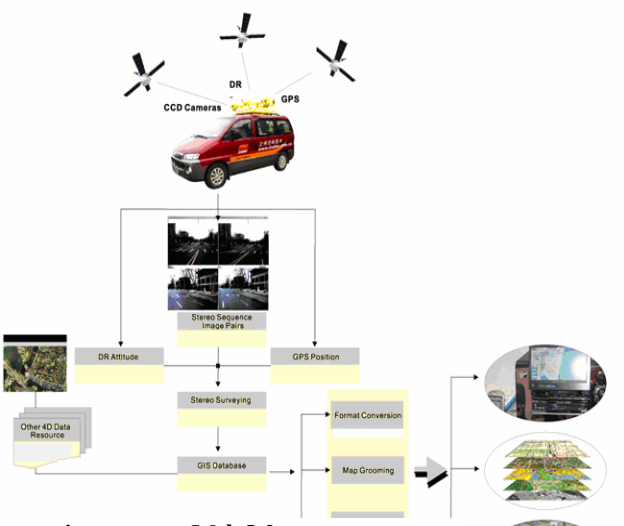
What Digital Earth can do for us? Let's see the functions of Internet at first. Internet is something more than information. Internet provides a platform of information sharing, searching and releasing. Currently, almost all mainstream business on Internet is involved with information.

As a media which carries more than 80% of information related to human activities, geo-spatial information plays more and more important roles on Internet services. On the other hand, the quick development of network (the 3rd generation of Internet), 3G and Grid technology and the coming out of Google Earth makes geographic information and 3S technologies available, which originally only can be reached by professional users. All internet users can carry out various kinds of web services, a majority of which is free, on a uniform web platform. The public geo-spatial services will improve the application and prevalence to a great extent and reduce fund devotion in application process, and therefore promote the explosive increasing of the whole business. Global geo-spatial information sharing plays great role in economic increase macroscopically.

At present, the realization of geo-spatial information services platform mainly rely on 4D product. With the improving of social information, the requirements for geo-spatial information are increasing. The internality, exactness and up-to-date of geo-spatial data play critical role for the quality and effectiveness of geo-spatial information services. With an eye to the developing trend of requirements for geo-spatial information services, the directions include mass, high-resolution, visuable and minable.

With he third Internet Tidal Wave, the concept of Digital Earth and corresponding technologies including Grid and Digital Earth brings new working mechanism for all kinds of business application. According to the concept of Digital Earth, the services provided for users need to satisfy the following six characteristics: Certainty, Experience, Communication, Variation, Creativity and Relation. As regards geo-spatial services, searchable is the basic attribution; visuable is the basis of Experience (e.g. Google Earth and Microsoft Virtual Earth); measurable is the guarantee of Variation and Creativity; minable is the guarantee of Relation. So we make the conclusion that searchable, visuable, measurable, minable are the four functions of Digital Earth.

Service platform based on geo-spatial grid can integrate Web 2.0 technology such as Ajax and provide interactive intercommunion service for users. The architecture of geo-spatial information services of Digital Earth is illustrated through Figure. 2.



Geo-spatial information service requirements on Web 2.0

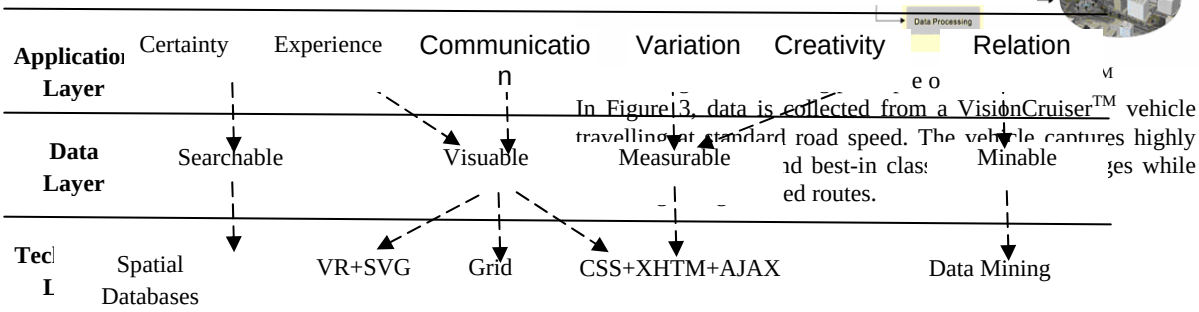


Figure 2 Geo-Spatial Information Service Requirements of Digital Earth on Web 2.0

2.2 VisionCruiser™ can satisfy the need of Digital Earth

2.2.1What is VisionCruiser™

VisionCruiser™ is designed and manufactured by Wuhan Leador Co., Ltd. from LIESMARS. The system integrates geodetic quality GPS, digital stereo cameras and inertial navigation system (INS) that are mounted on a land vehicle.

It proves to be the most rapid, convenient, accurate and economic tool of collecting and updating geomatics data. VisionCruiser™ has been used on over 220,000km of right of way in China.

2.2.2 How do VisionCruiser™ work?

VisionCruiser™ contains spatial semantic information which can not be described by traditional maps. VisionCruiserTM represents the physical situation of the true Earth and catches knowledge based GIS. Thus, the plentiful information of geography, economy and humanities contained in VisionCruiser™ is data source of geo-spatial services. The working principle of VisionCruiser™ is illustrated by Figure 3.

In Figure 3, data is collected from a VisionCruiser™ vehicle travelling at standard road speed. The vehicle captures highly ıd best-in class ges while ed routes.

As a new surveying technology, VisionCruiser™ provides Mobile Mapping System (MMS) which collects Digital Measurable Images (DMI) of roads and sideward objects as the vehicle, which is furnished with such sensors and equipments as GPS, CCD and INS/DR, runs in high speed. Users can implement measurement-on-demand between various elements, especially the elements besides the road, according to concrete applications based on these referenced DMI.

3. APPLICATION

VisionCruiserTM can provide the four functions of Digital Earth.

3.1 Searchable of VisionCruiser™

Through this function, the information of 4W (When, Where, What object and What change) can be achieved automatically, intelligently and in real-time and the service of 4A (Anyone, Anything, Anytime and Anywhere) can be realized.

Roaming in image space built on the basis of digital images acquired by Mobile Mapping System (MMS), we can get corresponding properties of certain interested object (i.e. bank or shopping mall) by clicking it. The operation is as easy as we do it on electric map. The difference is that query by images is

more humanistic and more accordant with the requirements of Digital Earth. As illustrated in Figure 4, the position of a pub is queried.

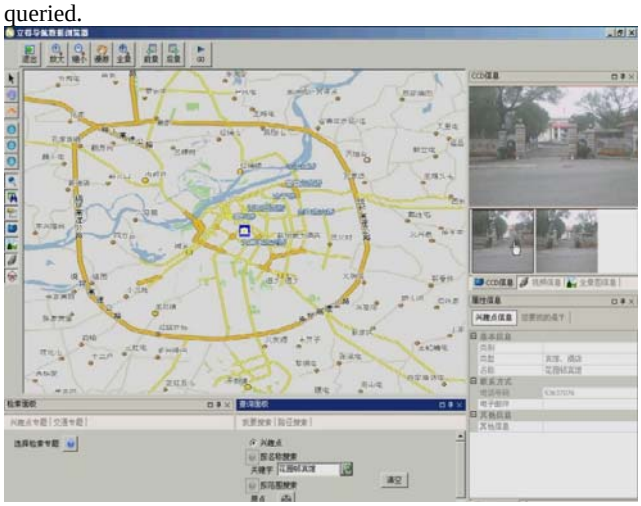


Figure 4 The query result of a pub

3.2 Visuable of VisionCruiser^{TM}

Here measurable 3D images are contained in the content of visualization other than vector data and raster image data. The goal is to make the representation of objects more vivid and comprehensive. Digital measurable images (DMI) collected by MMS are known as a new products introduced to spatial database. Mass referenced Digital Measurable Images accord with the custom of human activities, which cover information of geography, humanities and economy and have become the preferred product of visuable images series.

Visualization is the most intuitionist characteristics of VisionCruiserTM. A series of video images, which are obtained by double CCD cameras, are matched through image correlation technology. And therefore stereoscopic images are generated to reach the purpose of What You See Is What You Get. Figure 5 shows the visualization result of Qinghai-Tibet Railway, China.

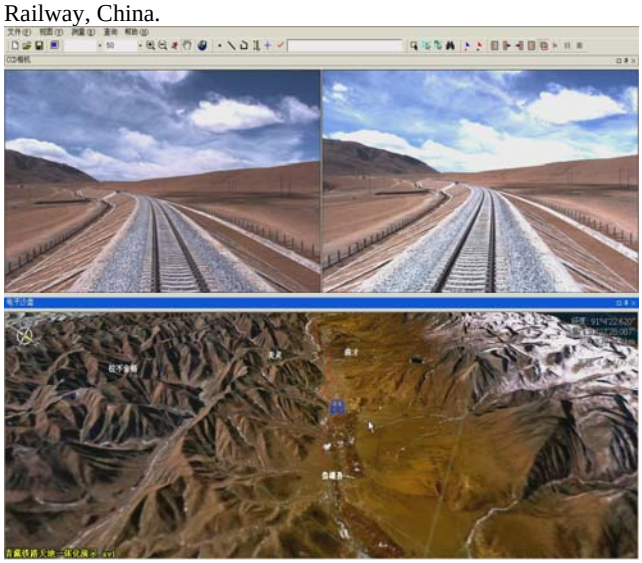


Figure. 5 the visualization result of Qinghai-Tibet Railway, China

3.3 Measurable of VisionCruiser^{TM}

The contents provided by VisionCruiser^{TM} are a general definition of 4D product and Digital Measurable Images (the fifth dimension product other than existed 4 Digital products DEM/DOQ/DLG/DRG). Users can customize concrete services according to their own requirements and implement direct and convenient browse, relative surveying, absolute posing and analytical surveying etc.

DMI gathered by MMS carries such data as External Orientation Elements and Attitude Elements. Cooperated with accurate time parameters, these data constitute the basis of surveying on multiple level and seamless merging of database.

Generally, the height and area information of a building is difficult to measure and the usual method is to get through querying attribute database which save these information by traditional surveying in advance. That is to say, if the information we interested are not stored in database beforehand, they cannot be reached through query operation. However in VisionCruiserTM, all information of an object including length, area, perimeter etc can be obtained in real time. Fig.6 shows a result of a real-time query. As shown in Figure 6, the distance from appointed site to telecom building is measured.

Figure 6The measured distance from appointed site to telecom building

3.4 Minable of VisionCruiser^{TM}

While the scene exhibited by 4D product is the projection of real world on 2D surface, the scene exhibited by VisionCruiser^{TM} is 3D images. This provides natural and social information which can be mined. Users can achieve attribute information mining through corresponding application software, plug-in and API according to their concrete applications. VisionCruiserTM offers extensive data support for further application including Visibility analysis, transportation ability, business position selecting.

The information that a great deal of users needs is that relating with professional application and personal lives such as electric equipment of Electric Power Department, Municipal Facilities of Administrative Department, safeguards of police department (fireplug and doorplate et al), traffic information of transportation department and position demand of dining-room etc. All the information can not be covered by traditional 4D product perfectly and effectively, while it can be gained by VisionCruiserTM.

For example, certain rule can be discovered from texture images according to content-based retrieval. Figure 7 shows the retrieval result of a McDonald's through texture information mining.

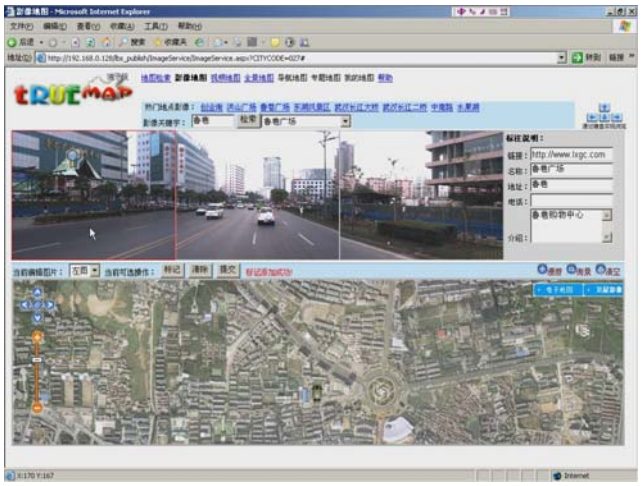


Figure 7 the mined result of navigation information through the texture feature of street scene

4. CONCLUSION

Based on the developing trend of requirements for geo-spatial information services, this paper gives the concept and technologies of Digital Earth, followed by analysis of the architecture.

An applied system, VisionCruiser^{TM,} is introduced to provide a solution to the four functions of Digital Earth. The Digital Measurable Images collected by MMS of VisionCruiser^{TM} provide a promising prospect to GIS application and geo-services and it is obviously more advantageous to existed 4D products.

In conclusion, with the ability of meeting the requirements of Measurement-on-Demand geo-spatial Information services for end users, VisionCruiserTM is a promising prospect for Digital Earth.

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