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Map creation for navigation and database updating based on cloud computing

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ABSTRACT

Navigation systems are gaining interest in research and industrial topic due to their wide usage. The method of updating the map database with previously unknown map information has become an important factor in navigation system design. Today, many map DB providers maintain their own datasets and work to reduce unknown map information in only their proprietary maps. Map updating systems is generally based on network and cloud based map generation and updating. This paper introduces the main difficulties associated with determining and updating unknown map information and briefly surveys the state-of-the-art technologies in this field. Further discussion of the cloud oriented DB updating of unknown map information is also provided and its advantages.

Introduction

Cloud computing is the delivery of computing services over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. The cloud computing model allows access to information and computer resources from anywhere that a network connection is available. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications.

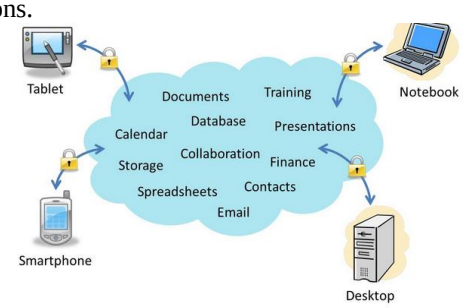

Fig. Cloud Computing Technology

A navigation system is a device which provides driver comfort and ameliorates safety by information, like current position, source to destination directions, road maps, traffic conditions, speed. The driver provides the destination point in the beginning and the navigation system then continuously sends the driver with all the travel information, which is retrieved from road map database, until the destination is reached efficiently. Navigation systems can also provide directions in different conditions, such as preferences made by the driver on the available routes to the destination. Due to the variety of constraints and complexity embedded in a navigation system, the function of updating the road map database on navigation system is established is critical to system performance. Because of their expanding feature list and increasingly wide use, navigation systems have gained research and industrial interest.

Particularly, the updating and distribution of the map DB is an essential, intricate and costly process worthy of detailed study. Real time map updating methods, those using wireless communication technologies, have not been widely considered for map generation and updating processes. Therefore, the process of updating map DB presently relies on the frequency at which the map DB provider and user update their map DBs.

Basically, if the driver wants to update the map DB of his navigational device from the master map DB, the driver connects his navigational device to the internet and manually checks its update status relative to that of the map DB. Thus, the real-time map generation and updating procedures are not supported and the user has to update the maps manually every time. Navigation systems presently require a user to download updated maps to a memory card, using the internet, and then attach the memory card to the navigation device. The intricate and inconvenient process of updating memory card is very time consuming, and the quality of the data is entirely reliant on the accuracy of the latest DB update. So, in this paper, we aim to survey the available methods for updating map information. Map updating systems can be generally classified into two fields, network and cloud-based map generation and updating. Particularly, the proposed method use cloud computing technology to solve the compatibility issues between map DB providers [1, 2, 3, 4].

Related Work

Map DB Information Service

Many open map API have been proposed in recent years. Open Street Map (OSM) is a global road map production project [5]. Open Street Map (OSM) is a collaborative project to create a free editable map of the world. The project has a geographically diverse user-base, due to emphasis of local knowledge and ground truth in the process of data collection. The initial map data were originally collected from scratch by volunteers performing systematic ground surveys using a handheld GPS unit and a notebook, digital camera, or a voice recorder. The data were then entered into the Open Street Map database. Google Map Maker provides the method to update information which is omitted in the Google map through the

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user's participation [6]. According to the map DB generation and updating methods by using map information in car navigation, several works were done before. In the road Map Air Update Server (MAUS) project, researchers have developed a mobile spatial Database Management System (DBMS) to enable updates to the partial map data that could not be updated in the conventional navigation system [7][8][9]. Through the *DigitalHub* Service, the navigation map information and driver's safety driving information are updated by using the Bluetooth base station installed at the gas station [10].

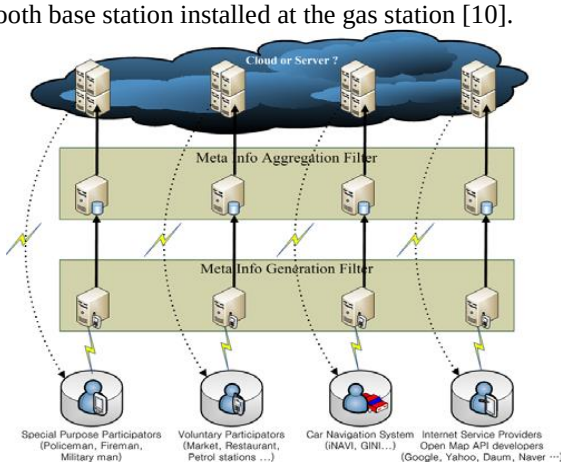

Fig 2. Concept of network-oriented map generation based on cloud or server computing

Toyota Motor Co., Ltd., announced the roadmap on Demand technology that it has developed to automatically deliver differential map data to car navigation systems [11]. *Honda Motor Co., Ltd.*, showed a demonstration of wireless updates to map information using mobile-phone networks.

In the Act Map project of Europe [12], the research regarding the interchange data format and the server-terminal system for partial map updates has progressed, and the prototype system has been developed since 2004, but this has failed to lead to commercialization. And, according to automated map DB generation and updating architecture in real time by using the Global Positioning System (GPS) information and detection of road images while driving unknown roads, when a user drives unknown roads that do not appear in the car's navigation map, the cloud-oriented car navigation system can effectively extract the GPS information and image information of the unknown roads. Subsequently, that extracted information is uploaded to the roadmap DB provider to enhance the master roadmap DB in the cloud. But, this method is that Internet Service Provider (ISP) and voluntary participators using mash up service were excluded. This is only updating method between the heterogeneous navigations.

Open DB Map Generation for Heterogeneous Environments

A. Network-Oriented Map Generation

Now, we introduce the network-based map generation concept for unknown map information extraction and map DB updating in the Cloud as in Fig.2.It presents the concept of map generation based on cloud computing. The Cloud or Server is consisted of the Meta Info Generation Filter and Meta Info Aggregation Filter. This scheme includes

1) The special purpose participators, voluntary participators, Internet Service Provider(ISP) and car navigation systems transfer the extracted map objects and characteristics from the navigation system and image information of the unknown map information to their map provider's Meta Info Generation Filter within the cloud or server through the wireless communication network.

2) The Meta Info Generation filter analyzes the reliability of the extracted information. If the extracted information is accurate, Meta Info Generation Filter transfer the accurate information of the unknown map information to Meta Info Aggregation Filter.

3) The Meta Info Aggregation Filter generates the metadata in the homogeneous map format available and updates the map DB

4) Each provider updates their GPS system through synchronization with the updated map DB.

B. Concepts of Open Map Generation based on Cloud Computing

We propose the cloud-oriented Open Map generation between heterogeneous systems for unknown map information extraction and map DB updating in the Intelligent Map Cloud as in Fig.3.The Intelligent Map Clouds are consisted of the Meta Info Generation Filter and Meta Info Aggregation Filter.

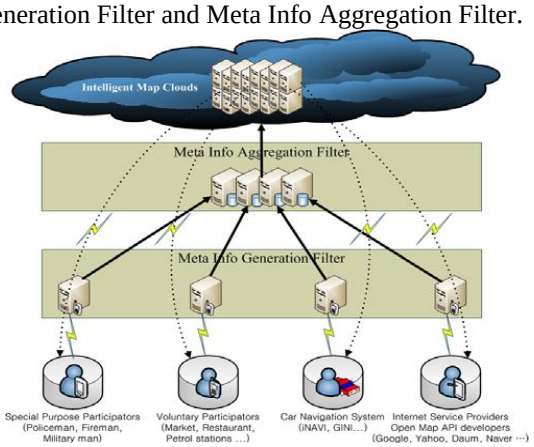

Fig 3. Concept of open map generation for heterogeneous environments based on cloud computing

When a user find unknown information in the GPs system, and the user transfers the retrieved map objects and attributes from the GPS and image information of the unknown map information to their provider within the Intelligent Map Clouds through the wireless communication network, the provider then transfers the information gathered from each user to the Meta Info Generation Filter and Meta Info Aggregation Filter within the Intelligent Map Clouds. The Meta Info Generation Filter and Meta Info Aggregation Filter then extracts the road characteristic information and generates the metadata in the XML format available for heterogeneous systems, and the cloud provides this generated metadata in XML format to each map DB provider. Lastly, the map DB providers change the received metadata to their provider DB formats and thereafter update the map DBs of all navigation systems. In contrast with Network-Oriented Map Generation as in Fig.1, Fig.3 shows a concept of open map generation for heterogeneous environments based on cloud computing. Here, the proposed scheme includes

1) The function of provider's Meta Info Generation Filter is same. But, Meta Info Generation filter transfer the accurate information of the unknown map information to the same Meta Info Aggregation Filter within the cloud, 2) the Meta Info Aggregation Filter generates the metadata in the XML format available for heterogeneous systems, and update the master map DB, and 3) the cloud update the all local system through synchronization with the updated master map DB.

C. Advantages of Cloud Oriented Navigation System

Since GPS Devices rely on software in order to function, many of its functions such as map and waypoint updates, patches to the code, and in some devices, even entertainment content can be hosted on cloud.

1. Always Up to Date – if your GPS device is not on the cloud, any updates you need have to be side loaded or installed manually. If it's on the cloud, you're sure that any patches to the code or updates to the content will be made available to you as soon as it is deployed. It's basically one of the main benefits of cloud technology being applied to GPS devices.
2. You Can Access Your Settings Anywhere at Any Time – another one of the benefits of cloud technology is that personal settings, configurations, and customizations are all stored in the cloud, so if a navigational device is lost, it can be replace it with a new one and download your old settings and you won't have to readjust to new settings. This also provides business continuity, as any problems on the part of the hardware will not affect the software hosted on the cloud, which means normal operations will resume as soon as the GPS device is replaced.
3. Sharing Capabilities –cloud based GPS devices can easily share information with others online, provided that the sharing is facilitated by the vendors and its support systems. Through this sharing system, waypoints, maps, traffic updates, and other custom content can be easily sent to your friends or family members. Additionally, this makes it easy to report to emergency services or law enforcement in case you need them to respond to a specific location.
4.Lowered Costs – since cloud based infrastructures are cost effective and does not require manufacturers to invest on their own hardware, they are able to save money, which usually trickles down to end users in the form of lower prices or better features and support.
5. Security – cloud based applications can be protected by vendors and their trained staff, instead of the security of your data being your sole responsibility. With cloud-based GPS, you can rest assured that your data won't fall into the wrong hands.

Conclusion

In this paper, we proposed a cloud oriented map generation concept and updating technology for heterogeneous systems for unknown map information. Updating of map information through the cloud environment can provide accurate map information. If some map information i.e. not known and that varies periodically, it becomes a very expensive and complex to update the DB maps with time.

Nonetheless, we proposed method based on cloud computing through which the complexity of generation and the updating of the DB maps can be reduced by the updating technique of navigational system maps through cloud DB server and also maintenance costs of the map DB data center is decreased. Finally, the cloud-oriented map generation method can update the unknown map information in the users map DBs more efficiently.

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