

Application of Internet+ Field Survey Technology in China's Land Management

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SUMMARY

Field survey is one important link of land management in China. Field survey technologies involve land survey, monitoring, law enforcement, and other management areas such as using remote sensing to monitor land use changes as well as investigation and handling of illegal land use. In recent years, China Land Survey and Planning Institute researched Internet+ and "3S" integrated field survey technology and widely applied them into the land management work in China and achieved remarkable results. In China's annual remote sensing and land change survey, local land surveyors used mobile phones to carry out field survey about the change information shown by remote sensing monitoring. In land law enforcement and inspection, surveyors used mobile phones to provide proof for map spots with illegal land use. The field survey technology based on Internet+ is a new model of land survey and supervision that effectively improves working efficiency and ensures the authenticity of the survey data.

Field survey and verification is an important means to understand and grasp the status quo of land as well as the basis and a necessary link for land management. Once a year, the Ministry of Land and Resources of China will organize and carry out nationwide land management work, including land remote sensing monitoring, land change survey, and land law enforcement and inspection. It uses a great deal of manpower and material resources for land survey and verification. With the advance of technologies and guidance of demands, the level of field survey technologies has also developed and improved. The first national land survey used plane table and other measuring instruments. The second national land survey used GPS-RTK and other equipment for digital survey. In recent years, Internet technologies are also used for field survey and verification.

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1. REQUIREMENTS ON FIELD SURVEY AND VERIFICATION PUT FORWARD BY LAND MANAGEMENT

The core of China's land management is land use control, namely, specifying land use through the overall land use planning. The basis of land use control is to conduct classified survey and generate basic survey data according to the nature and use conditions of land. Meanwhile, approve land in strict accordance with their use and severely punish acts that violate the planned use of land. Field survey and verification is the key link of the aforementioned land management work. Authenticity, accuracy, speediness, and efficiency are the core requirements on field survey put forward by land management.

Authenticity and accuracy are the prerequisites of field survey, especially for China's land management which treats land use control as the core. During local daily land management, there may be situations where local and short-term interests and the country's long-term and overall interests are inconsistent. This may lead local authorities to practice fraud in land use survey, verification of suspected illegal land use, and other field work, rendering the survey results unreal. In addition, because China has a large territory and field survey technologies used by some economically underdeveloped areas are backward, the accuracy of the survey results may not meet requirements. To tackle this, for the above land management work, the Ministry of Land and Resources has set up special inspection procedures and put in place a professional technical team to inspect the authenticity and accuracy of survey results. For example, in the second national land survey, the work procedure of national indoor inspection, and local onsite verification, and national field verification has been used to check the quality of field survey data.

Speediness and efficiency ensure the timeliness of survey results and that the results meet the requirements of land management. High quality and efficiency are the common goal for all kinds of survey work. However, sometimes too many quality inspection of survey result quality often means a longer survey period and lower efficiency. For example, though the quality inspection procedure of multiple inspections and repeated verification adopted in previous land survey work ensures the quality of survey results, it also severely impacts the timeliness of survey results and increases the overall investment of manpower and material resources. To solve these problems, using new technologies or approaches and optimizing the survey and quality inspection procedure so as to ensure both survey result quality and efficiency are the requirements on field survey and verification put forward by land management.

2. INTERNET + LAND FIELD SURVEY TECHNOLOGY AND APPROACH DESIGN AND PLATFORM DEVELOPMENT

2.1 Core of Internet+ Field Survey and Proof Provision Technology

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March 5 2015, Premier Li Keqiang put forward the “Internet+” action plan for the first time in the National People’s Congress Government Work Report. With the high degree of attention and support from the central leadership, China’s cloud computing and Internet+ technologies have gained rapid development and application. Meanwhile, smart terminal devices have achieved rapid development and popularization. Most smart phones have GPS positioning, 4G communication, electronic compass, high-resolution video shooting and other functions. These technological advances and the popularization of smart devices have laid the foundation for the realization of Internet+ land survey technology.

Internet+ survey technology makes full use of mobile Internet, cloud services, and 3S (RS/GIS/GPS) integration technology. It innovates on existing information collection and monitoring technologies. Surveyors use smart phones to collect comprehensive information such as land boundary, onsite photos, GPS location, shooting direction, and shooting time. Survey and proof information are encrypted and transmitted over Internet and then stored on cloud servers. The reviewers conduct reviews and real-time monitoring online, which ensures the authenticity of the survey results while greatly reducing capital, manpower, and time costs during information transmission. For a mobile phone, the positioning accuracy of A-GPS is around 10m, the direction accuracy of the electronic compass is not more than 15°, and the resolution of onsite photos is about 1024*768, which can meet the requirements of survey, proof provision, and verification. The following figure is a schematic diagram of using a mobile device to provide proof of five elements which are person, time, device, coordinates, and direction.



Figure 1: Five-element proof provision

2.2 Design of the Overall Technical Framework for Internet+ Field Survey

According to the national network security and confidentiality requirements, the overall technical framework for Internet+ field survey includes 5 parts: the intranet working platform, extranet cloud platform, field scheduling platform, encryption survey terminal, and mobile proof provision terminal. The intranet working platform mainly processes data. The extranet cloud platform mainly stores field survey data. The field scheduling platform mainly distributes and schedules field tasks. The encryption survey terminal is used to carry out field survey. The mobile proof provision terminal is used for field proof provision. The data in the intranet and extranet are separated and exchanged through network security devices. The overall technical framework for Internet+ field survey is shown in the figure below.

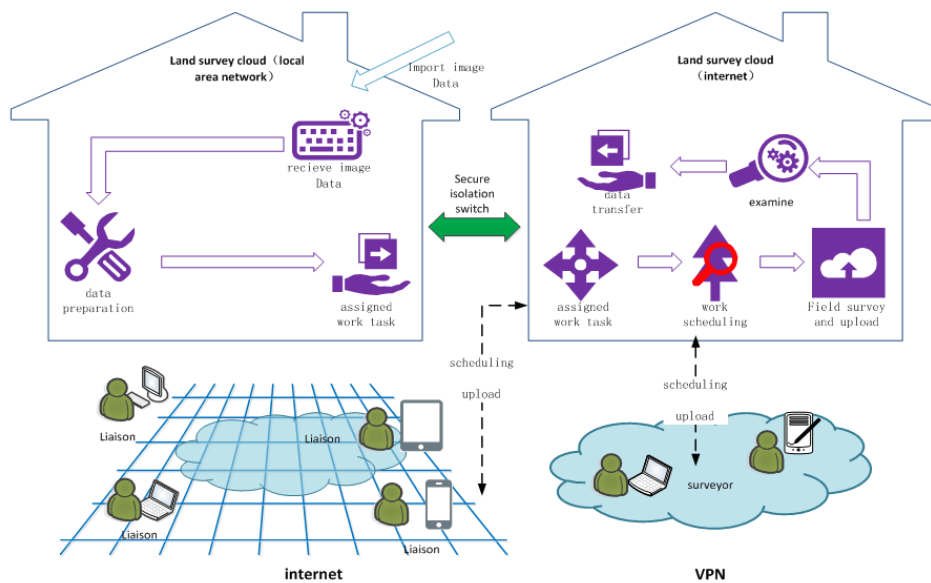


Figure 2: Overall technical framework for Internet+ field survey

2.3 Development of the Internet+ Field Survey and Proof Provision Platform

The Internet+ field survey and proof provision platform is divided into five layers: operating system layer, database layer, platform support layer, application layer, and presentation layer.

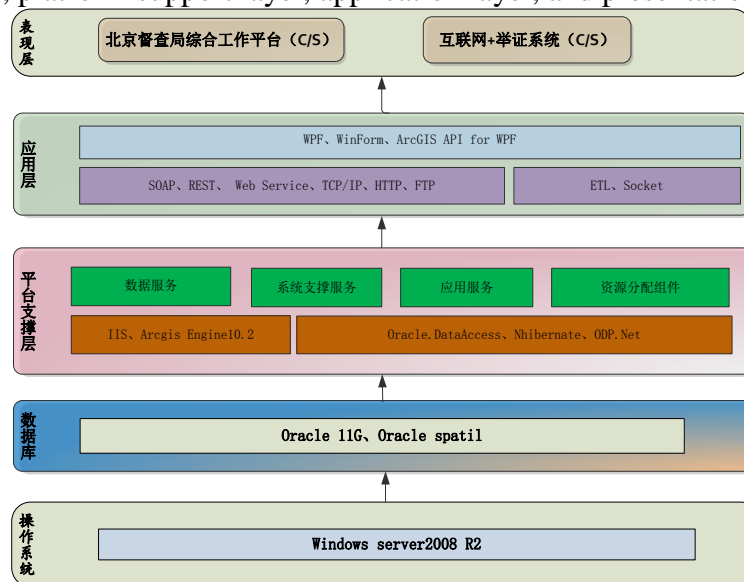


Figure 3: Design of the Internet+ Field Survey and Proof Provision Platform

(1) Operating system layer

Windows Server 2008 R2 Enterprise Edition is used.

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(2) Database layer

The database is Oracle11g 11.2.03 and the vectorized data storage is Oracle spatial storage.

(3) Platform support layer

The platform support layer is the pivot of the application layer and the database. It provides data service, system support service, application-related service, and resource allocation function for the application layer.

It uses technologies such as Oracle.DataAccess, Nihernate, ODP.Net to access the database. It uses IIS7.0 to release various services and map services. It uses secondary development of Arcgis10.2, a third-party GIS platform, for analyzing vector data.

(4) Application layer

It mainly includes service access, interface display, map display, and ETL. It employs soap protocol, webserver technology, TCP/IP protocol, http protocol, socket service, etc.. The user interface is a combination of wpf+winform. The client's map is displayed using the arcgis for wpf component.

(5) Representation layer

It mainly includes two application systems:

One is the system's application working platform. The platform uses the C/S architecture and is developed using C++ language, meeting the requirements of indoor work.

The other one is the Internet+ proof provision system. Its desktop terminal uses the C/S architecture and is developed using C++ language. Its mobile terminal is developed using java language and uses the mvc architecture, meeting the requirements of field proof provision.

3. APPLICATION OF INTERNET+ LANDFIELD SURVEY TECHNOLOGY

From 2007 to 2010, China has organized and carried out the second national land survey and established a national land survey database. Since 2010, the Ministry of Land and Resources has organized and carried out the annual remote sensing monitoring and change surveying work every year. It has collected nationwide satellite remote sensing images with a resolution about 2m, extracted land use change information, and organized local governments to conduct field survey and provide proof. Then it verifies data online and updates the land survey database. Meanwhile, the land law enforcement and supervision departments of the Ministry of Land and Resources have organized inspections on illegal land use.

Internet+ land field survey technology has been fully applied into local field survey and proof provision, national verification, and inspection of illegal land use. The nation uses the intranet working platform to process image data and push the land use change information to the extranet cloud platform. The field scheduling platform then distributes the information to the mobile device of the surveyor. With the aid of the up-to-date satellite image and GPS, the surveyor carries out the onsite field survey using a mobile proof provision terminal. The survey and proof provision information is then sent to the cloud platform over the Internet in real time. The national reviewer can use the field scheduling platform to command the surveyor remotely and connect to and review the field survey online in real time. Internet+ field verification and proof provision has completely

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changed the phenomena of repeated local proof provision, repeated national onsite field verification, and waste of social resources in the past. It has also become a new model of field survey, proof provision, and online supervision. The flow chart of field proof provision is shown in the figure below.



Figure 4 Flow chart of Internet+ field proof provision

The Internet+ field survey and proof provision platform features strong reliability, high efficiency, and low deployment and application costs. Local governments do not have to equip special survey equipment. The proof provision APP is easy to operate and requires no special training, thus making it easier to be deployed, promoted, and applied at scale in the country. In 2016, using the Internet+ field survey and proof provision platform, China Land Surveying and Planning Institute completed the field survey and verification of the land use in over 50,000 land blocks of 526 counties and 31 provinces in China. In less than half a month, Beijing Inspectorate of the Ministry of Land and Resources, by using the Internet+ field survey and proof provision platform, commanded county investigators located in Beijing, Tianjin, Inner Mongolia, Hebei, and Shanxi in North China to complete the field verification, proof provision, and review of nearly 20,000 map spots of suspected illegal land use.

4. CONCLUSION

Through the design and implementation of Internet+ land field survey technology as well as its extensive application in China's land survey and illegal land use inspection, land survey information acquisition and quality inspection are integrated, creating a new model that uses Internet for land field survey, proof provision, and online supervision.

Currently, in the Internet+ land field survey platform, we are using mobile survey devices and a RTK-compatible CORS network system to improve the land survey accuracy. We are using VPN to encrypt and transmit data to the cloud platform. Our goal is to build a land survey data acquisition system integrating space, air, and ground, to integrate and connect the space-air data acquisition

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system with the ground survey system, and finally, to form a scientific, fast, and efficient land survey technical system.

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