

# KUAINIAO PATROL INSPECTION SYSTEM BASED ON 4G INTEGRATION TECHNOLOGY

ZHANG Ji-Zhong<sup>a</sup>, LIU Xiang-Lei<sup>b</sup>

<sup>a</sup> Geographic Information Co., Ltd. Aerial Photogrammetry and Remote Sensing Bureau., 710054 Jianxijie 3 Xi'an Shaanxi Province, China - zjz9108651@sohu.com

<sup>b</sup> Dept. of Surveying and Geo-Informatics, College of Civil Engineering, Tongji University, 200092 Miyun Road 528 Shanghai, China - 16331316@qq.com

**KEY WORDS:** 4G, GPS, GIS, GSM, Kuainiao Patrol Inspection, KML

## ABSTRACT:

The pipelines of oil and gas well, oil and gas transmission, power transmission and so on are put in field and it needs regular patrol inspection. Pipeline patrol inspection system based on GIS, GPS and GSM solve the disadvantages of traditional patrol inspection model and improve the patrol inspection efficiency, and it also can describe the pipelines and its ancillary facility in detail with the powerful geographic information techniques, it has been extended rapidly in the pipeline inspection work. However, Pipeline patrol inspection system based on GIS, GPS and GSM also has some disadvantages; it just describes the pipelines and their surrounding on the electronic map with the simple GIS Data such as points, lines and polygons. Because it can not give a true representation for the pipelines and their surrounding scenes, it's feeble to display the objective world compared with the real world. With the global high-resolution images of geographic data and supporting overlaying vector data on the Google Earth client, Google Earth can solve the problem above. So we introduce Google Earth to pipeline patrol inspection work and do some researches on how to make full use of the advantages of GIS, GPS, GSM and Google Earth to inspect pipelines. According to the advantages of GIS, GPS, GSM and Google Earth, after analyzing the feasibility of integrating them, this paper presents a 4G integration technology, and introduces the methods of 4G integration technology. In the paper, the work principle, the system features and the application range of Kuainiao patrol inspection system based on 4G technology are introduced in detail. At last, this paper makes a prospect for the development of 4G integration technology and Kuainiao patrol inspection system.

## 1. INTRODUCTION

We have to carry out regular inspection of oil-gas wells and the pipelines, including oil, gas, power transmission, etc. Because oil-gas wells and the pipelines are in the wild, often destructed suffering from the natural environment changes and man-made. In addition we have to face the problem of aging equipment. In the reality, pipelines have the characteristics of large cross-border and long path, therefore it is important to introduce the advanced technology to the inspection, and then we can improve inspection efficiency and save manpower, material and financial resources. At present, the advanced technologies of GIS (Geographic Information System), GPS (Global Position System), GSM (Global System for Mobile Communications) have been integrated in the pipeline inspection system, and the pipeline inspection system has been promoted quickly, which has been overcome the shortcomings of the traditional inspection and improved inspection efficiency. But the pipeline inspection system based on GIS, GPS and GSM also has shortcomings, which can express the pipelines and its environment only through point, line, area based on GIS data, can not represent the reality environment of pipelines and surrounding, its performance ability compared with the real world seems pale and weak. The emergence of Google Earth provides a good solution to this problem, which has the global high-resolution geographic image

data, and support vector data superimposed on the image. The authors put forward the solution of integrating Google Earth, GIS, GPS, GSM to the pipeline inspection system, this system is named Kuainiao patrol inspection system, which will bring a new technological innovation.

## 2. 4G INTRODUCTION

4G technology refers to the GPS, GIS, GSM, and GE. With the development of science and technology, each of 4G has been developed rapidly. In practice, each of 4G plays an important role.

GPS stands for the Global Positioning System, it is an information service system that can provide three-dimensional position, velocity and time, at any time, any place. In recent years, GPS technology is widely used in military, scientific research, as well as transportation, surveying and mapping, communications, construction, oil exploration, national economy, etc.. And even has penetrated into people's daily lives, such as the residential intelligent management and medical care and so on.

GIS stands for Geographic Information System, GIS is an especial and important kind of spatial information system and its

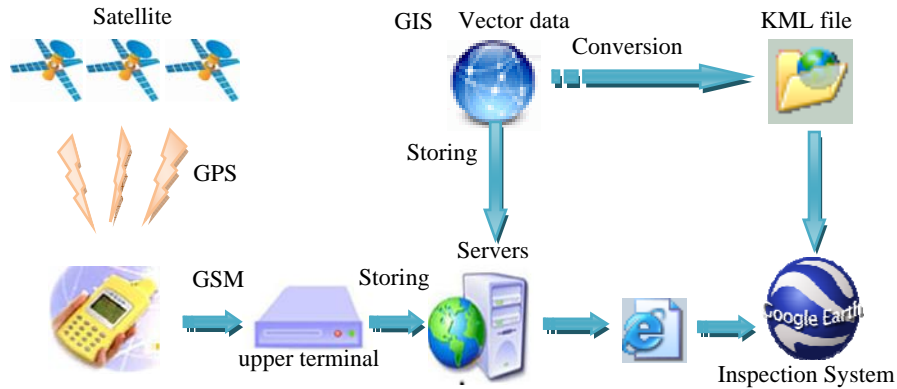


Figure 1. The Flow Diagram of 4G Integration Technology

function includes collection, storage, management, analysis, description and application of spatial data and geographical data. Specially, basing on geospatial database and using geographic model analysis method, it is an high-tech for storing and processing spatial information. First based on actual need, GIS can associate geographical location and attribute information perfectly and can provide the accurate output with illustrations and pictures; Second GIS integrates computer graphics and databases, and can provide the spatial and dynamics geographic information; Last, with its unique spatial analysis and visualization, GIS can provide various decision support.

GSM (Global System for Mobile Communications) is the wireless mobile communication system, also known as the public network or cellular wireless communications technology. GSM covers the largest area in China, and is the most reliable wireless mobile communication systems . It is widely used in transportation, vehicle monitoring, tourism, pipeline inspection and many other aspects.

GE (Google Earth), GE is the burgeoning force in GIS, and caused a sensation, with excellent audio and video streaming technology and high-resolution images of global geographical data. The research of Google Earth has become a hotspot and an important domain in GIS.

### 3. 4G TECHNOLOGY INTEGRATION METHODS

The key technologies of 4G integration are as follows: the GPS coordinate data is transmitted by GSM, and then is expressed in Google Earth; The GIS foundation geographic data is matched accurately to image data of Google Earth. The flow diagram of specific 4G integration method is expressed by figure1.

The processing methods of key technologies:

1. The processing method GPS inspection data. The GPS inspection data is transmitted to upper terminal through GSM network, after parsing, the information is stored in the database.
2. The processing method of foundational data. The main function of basic geographical data is the interpretation of Google Earth image data. The approach has two, one is to convert basic data directly into a KML file as the background image data of interpretation; the other is that the coordinate information saving as the style of coordinate string and the attribute information are stored in database, then servicing for the system queries.

The Google Earth data presentation. The coordinate data string and GPS data can be obtained through the WEB from the database, then data can be converted into KML file that can be expressed in Google Earth in real time.

## 4. KUAINIAO PATROL INSPECTION SYSTEM

### 4.1 System Architecture Figure

In Kuainiao Patrol Inspection System, the technologies of GPS, GIS, GSM and Google Earth are integrated into an organic whole. The system architecture is expressed by figure2.

### 4.2 System Composition

The total system consists of kuainiao patrol-instrument and inspection information system.

Kuainiao patrol-instrument based on 3G (GIS, GPS, GSM) technology can transmit real-time dynamic data to the remote center database on-site, thus the problems of data acquisition and data transfer can be solved essentially and a huge communication network construction and maintenance costs are saved. Kuainiao patrol-instrument fully comply with the requirements of ordinary pipeline inspection. Working parameters of Kuainiao patrol-instrument are showed in Table 1.

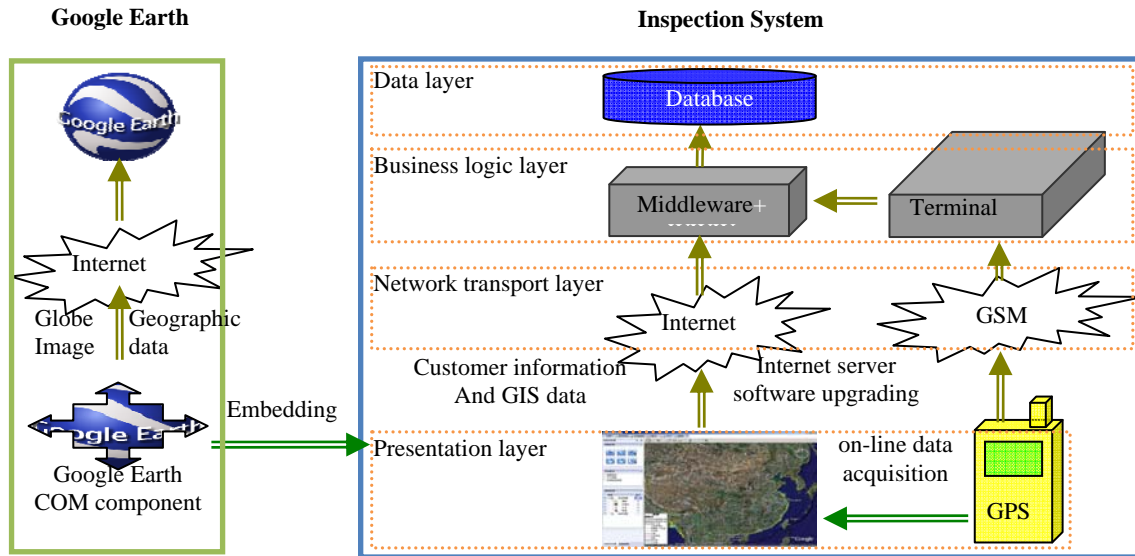


Figure 2. Kuainiao Patrol Inspection System Architecture

GPS positioning accuracy	<=10m
Positioning time	Cold start <=45s, Hot Start <=3s
Stand-by time	15-20h
Work capacity	1000 records of position, time and status
Work conditions	temperature: -30° C to +70° C moisture: 20%RH to 90%RH (normal pressure)

Table1. Working Parameters of Kuainiao Patrol-Instrument

Kuainiao patrol-instrument provides easy operation. On-the-spot inspection, firstly the relevant attribute data entry to patrol-instrument; Secondly pressing the "Send" button, the attribute data, three dimension coordinates and time are transmitted to the remote center database; Lastly, after the appropriate data processing in the management centers, then the results immediately are expressed in the Google Earth client to achieve operation management visualization and the real scene reproduction. So the administrative personnel can realize standardized management and scientific supervision in the process of inspection.

Powerful management ability and real-time monitoring function are excellences of the Kuainiao inspection information system based on 4G technology. The administrative personnel can supervise the dynamic route tracing the inspectors position, so putting an end to no inspecting and greatly eliminating the potential accidents.

The Kuainiao powerful inspection information systems, specific functions are as follows:

1. Map display. The customer's geographic data from the database and Google Earth map are expressed in system software. and support for other network services, such as weather, 51 maps.
2. Archives management. Using the modularization management and having the functions of unit management, team management, and patrol-instrument management, key management, pipeline management, inspection plans and inspection records management.
3. Inspection query. Including daily inspection query, real-time inspection query, pipelines query, real-time exception query and critical point query. And supporting line playback of inspection process.
4. Query statistics. The main functions are data inquiries and statistical reports. Including the archive query, inspection statistical reports and maintenance of information queries.
5. System configuration. Includes user management and system configuration of two sub-modules.

### 4.3 System Characteristics

Kuainiao patrol inspection system based on 4G integrated technology inherits the advantages of traditional inspection system based on 3G technology, and embodies the features of Google Earth, which has the following characteristics:

1. Reproducing the real scenes: We can make full use of Google Earth's high-resolution image data, merging the images into the inspection system and reproduce the real scenes of inspection.
2. Image interpretation: Google Earth have not the function of image interpretation, Kuainiao patrol inspection

system converts traditional GIS vector data into a KML file added to Google Earth, realizing the interpretation of image data.

3. Real-time playback: The flight routes based on inspection data can be simulated on the Google Earth, the true inspection processing get reproduced.

4. Increasing productivity: Data query and production scheduling can be completed in an instant, just what click, what get. Text messages instead of paper report and vehicles, the problems of acquisition and data transfer get solved essentially. Considerable time and expense can be saved by transmitting on-site inspection data to remote management center with GSM public network.

5. Reducing the rate of accidents: The potential causes of accidents can be eliminated essentially, by analyzing the layout of pipe and using information technology, supporting by Google Earth high-resolution images.

## 5. CONCLUSION

3G integrated technology is now widely used in all aspects, with the emergence of Google Earth, 4G technology research and application integration will become a hotspot of the GIS research. Google Earth is only in the initial stages and the development of its research and application are also in the exploratory phase. But with the continuous development of Google Earth and the continuous exploration in depth, 4G technology will lead the trend of the information times.

The Kuainiao inspection system not only has the advantages of 3G technology, but also has integrate the advantages of Google Earth to 3G technology, a new product was created based on 4G integrated technology. 3G technology has increased inspection efficiency and accuracy, and has enhanced inspectors's self-confidence. The Kuainiao inspection systems are widely applied, with the system's continuing promotion and improvement, the Kuainiao inspection system will play an increasingly important role, in fields of power, telecommunications, oil industry, pipeline inspection, water and other industries.

## REFERENCES

- [1]Wang Yanliang and Huang ming, 2004. Field patrolling and checking system basing on GIS/GPS. *Engineering of Surveying and Mapping*. No. 13
- [2] Li luqun, Li chengming and Lin zongjian, 2002. Data Structure of Sliced Saving Vector Data for PDA. *Acta Geodetica et Cartographica Sinica*. No. 31
- [3]Shuai kaide and Hu huiping, 2005. Multi-functional Tourist Service System Based on GIS, GPS&GSM. *Geomatics & Spatial Information Technology*. No. 28(
- [4]Zhang Jinming and Fu yongheng, 2007. Design and Implementation of LBS System Based on GPS/GPRS. *Bulletin of Surveying and Mapping*. 11
- [5]Zhao juanping and Zhan desheng, 2007. Patrol Electric Power System Based On GPS. *Control & Automation*. No. 23
- [6]Wu guozhong and Teng junqing, 2004. Development and application of data collection software for inspection tour system. *Journal of Zhejiang University(Engineering Science)*. 38
- [7]Chen shupeng, Lu xuejun and Zhou chenghu(eds.), 2001. *Introduction to Geographic Information*, Science Press, China, Peking.
- [8] Song guanfu, 1998. Study on Components Geographic Information System. PhD thesis, Institute of Geography Science and Natural Resouce Research