

# THE DEVELOPMENT OF INFORMATION SYSTEM OF URBAN INTEGRATED PIPELINE NETWORK BASED ON MAPOBJECTS

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### ABSTRACT:

The urban integrated pipeline network transfers information and energies day and night for the city, therefore, the information system of urban integrated pipeline network is crucial for urban planning and management. This system provides an effective platform to store, manage and analyze the integrated pipeline network data. This paper introduces the method of constructing the system based on the United States ESRI's MapObjects2.3, Visual Basic 6.0 and SQL database and describes how to use the GIS technology for effective management of urban integrated pipelines. Further more, this system has a friendly interface to all the users with less investments. Overall, we divide the functions of this system into four parts: pipeline network management, pipeline network analysis, pipeline network maintenance and safety management. The system is applicable to the medium and small cities with some intelligentized day-to-day management functions, such as the conversion of the original data, intelligent browse of the maps, inquiring and statistic, profiles, measurement functions and so on. One of the browse functions is the "Eagle Eye" window, which offers a breviary map to the users. This system might be an useful and economical tool of high technology to manage medium and small zones. It will have abundant reference value for the similar system.

## 1. INTRODUCTION

With the fast development of our country's economy, the course of the basic-establishment is more and more complex, therefore, the management of the city planning is more and more important, especially the management of the integrated pipelines network. Integrated pipelines are important components of urban infrastructures, which are known as the city's "lifelines". Master and understand the status of urban integrated pipelines can avoid the pipeline accidents, which also can guarantee the people's normal productions and life.

Previously, because of the financial and technical reasons, the urban integrated pipelines network data has been recorded at paper format and stored at different administrative departments for a long time. Up to the present, China's urban integrated pipelines network are still not unified planning and managing, inevitably, which frequently cause the incidents of damaging integrated pipelines among the various departments, and also cause the huge economic losses not only to the country but also to the people's life in our city. So it is imperative to change this state of affairs. In recent years, with the development of computer graphics technique and geography information system technology, we can construct an information system for urban integrated pipeline network. This system provides an effective platform to store, manage and analyze the integrated pipeline network data.

In foreign countries, the management of integrated pipeline has reached a very high level. Canada is the birthplace of GIS, however, it also lives in the forefront of the world on the pipeline management. At present, the technologies on the management of pipeline are relatively mature, especially in

America and Japan. The United States had built an Urban Power Information System in the mid-1970s, and Japan also had developed an Urban Geographic Information System in the early 1980s. In China GIS technology developed a few years ago, so our country is still in an initial stage on the management of the integrated pipeline. But after struggling studies and researches for several years, we have got some prominent achievements in the field of GIS. Beijing Heat Pipeline Network Integrated Information Management System is outstanding among the achievements, which is built by Beijing SuperMap Company and Beijing Hangnuo Science and Technology Company.

Currently, most of the built management systems of urban integrated pipeline networks are applicable to the large cities, but whose technologies are complex, and the cost are also expensive. In China, however, there are so many medium and small cities, so the system in this paper is mainly to meet the needs of medium and small ones, which requires a simple system that is operated fleetly and expediently. Next, we try to introduce some of our core works.

## 2. SYSTEM DESIGNS

### 2.1 Platform

This system chooses the United States ESRI's MapObjects 2.3 and Visual Basic 6.0 as the programme languages. And the whole system runs on the Windows operating system platform. MapObjects (MO) is a collection of mapping components for application developers, consisting of an ActiveX control and

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other programmable ActiveX automation objects. It is built on the Microsoft link and is embed objects (OLE) 2.0. OLE is the software integration technology of object-oriented which is the most widely supported currently. MO consists of an ActiveX control with nearly 50 automation objects that can be plugged into a variety of development frameworks including Visual Basic, Visual C++, Visual Studio .NET, Delphi, PowerBuilder, and others.

### 2.2 Design Route

Firstly, we use DAO control in VB 6.0 visiting the original data with the format \*.mdb. Secondly, the access data are changed into shape files via MO components in VB 6.0, as MO sustain the \*.shp format but not the \*.mdb format. Finally, this system can read the shape files then implement management functions of urban integrated pipeline network system. The Quickbird image with the resolution of 0.6 meters is also added to the system as the base map. Figure 1 outlines the steps of completing the system.

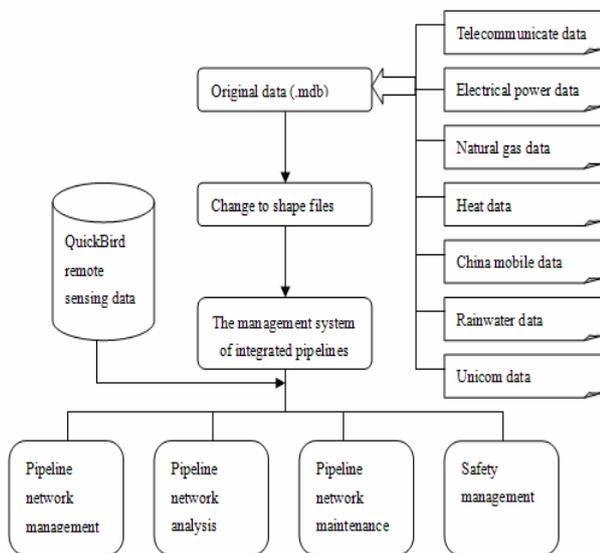


Figure 1. Flowchart for the technology route of the system

### 2.3 Design Functions

This system prepares to complete the daily management functions of the integrated pipeline, also shown in figure 1, including: pipeline network management, pipeline network analysis, pipeline network maintenance and safety management functions. In detail, it also includes the functions that accessing and editing the shape files data, browsing intelligently the graphics of pipeline network, displaying and interactive inquiring the information of graphics and attributes, generating the cross-sections and analyzing the connections of the selected pipelines. Finally, the users can print any information and graphics of the integrated pipelines they want.

## 3. DATA ACQUISITION AND CONVERSION

The system of integrated pipeline management includes two categories data: integrated network data and image data. However, the network data is the key to the entire system and plays a vital role to build and use the system.

### 3.1 Data Acquisition and Structural Design

The test data is the pipeline data of JiaoZhou city, whose original format is \*.mdb, and an Quickbird image with the resolution of 0.6 meters as a base map to this system. Pipeline Data is mainly composed by the spatial location data of the pipe points and the attribute data of the pipelines. The Original data are divided into seven categories: electric power, Unicom, heat, telecommunications, rainwater, natural gas and China Mobile Data. The data of MapObjects includes geographic database (spatial database) and non-geographic database (attributes database). What's more, spatial database records the space location of the pipelines and pipe points, as well as their relative attribute information. The data structures and attributes are shown in table 1,2.

| Number | Field                | Type          | Length |
|--------|----------------------|---------------|--------|
| 1      | ID number            | Long Integer  | 8      |
| 2      | This point name      | Float         | 8      |
| 3      | X-coordinates        | Double Float  | 12     |
| 4      | Y-coordinates        | Double Float  | 12     |
| 5      | Pipeline type        | String        | 20     |
| 6      | Ground height        | Double Float  | 10     |
| 7      | Road                 | String        | 20     |
| 8      | Depth                | Float         | 10     |
| 9      | Material             | String        | 12     |
| 10     | Point Diameter       | Short Integer | 5      |
| 11     | Date                 | Date          | 20     |
| 12     | Ancillary facilities | String        | 40     |
| 13     | Remarks              | String        | 40     |

Table 1. Table of pipeline point features

| Number | Field                | Type         | Length |
|--------|----------------------|--------------|--------|
| 1      | ID number            | Long Integer | 8      |
| 2      | This point name      | Float        | 8      |
| 3      | Last point name      | Float        | 8      |
| 4      | Length               | Double Float | 12     |
| 5      | This point height    | Double Float | 9      |
| 6      | Last point height    | Double Float | 9      |
| 7      | Pipeline type        | String       | 20     |
| 8      | Depth                | Double Float | 10     |
| 9      | Material             | String       | 12     |
| 10     | Pipeline Diameter    | Long Integer | 5      |
| 11     | Date                 | Date         | 20     |
| 12     | Road                 | String       | 20     |
| 13     | Ancillary facilities | String       | 40     |
| 14     | Remarks              | String       | 40     |

Table 2. Table of pipeline line features

### 3.2 Data Conversion

This system uses DAO (Data Access Objects) technology to visit access database. Firstly, we create variables to each object of the database based on the Dim statement. Then, we set up an

initial display range and Open the database which you want to connect using the OpenDatabase function. Next step is reading the X-coordinates and Y-coordinates of the points in the range which just set up using the OpenRecordset method, the whole course is called spread points. Finally, we create a blank table of TableDescription and all the fields are shown in Table1,2. Then, the corresponding information is filled in that table and which is saved as shape files in the appointed path.

After creating the points, we must connect the relevant points to lines. Because there are "this point name" and "last point name" fields in the pipeline attribute table, see table 2. Firstly, we read the "this point name" field of the first record, and then find the corresponding X-coordinates and Y-coordinates of this point in the pipe point table, so we could locate the first point. Similarly, we read the "last point name" field of this point in the pipeline table, then find the corresponding X-coordinates and Y-coordinates of the last point in the pipe point table, so we also could locate the last point. Finally, we connect the two points which are just located to one line. Then we fill the attribute of this line in the blank table of pipeline which is created in advance and save it as a shape file. Now, we complete the change of the points and lines to shape files.

#### 4. THE MAIN FUNCTIONS

In accordance with the needs of practical applications, the system of the integrated pipeline management is divided into four main functions: pipeline network management, pipeline network analysis, pipeline network maintenance and safety management.

##### 4.1 Pipeline network management function

The pipeline network management includes intelligent browsing for the pipeline data and base map, querying and printing functions.

**4.1.1 Browsing Function:** Graphics displaying and data browsing includes many manners, such as full size, zoom in, zoom out, pan, layers display and information functions. All of these functions can implement respectively in the menu, toolbar or the right mouse menu. At the same time, the system provides a tagging function of the pipeline network. You can select arbitrary fonts, colors and sizes of the elements for pipeline network to tag based on the existing attributes of the points and lines of the pipeline network, which is better for users to browse and observe. Besides, the function of geographical coordinates display can show the users the current location of the mouse.

The breviary display window is also called "Eagle Eye" window. When the display scope of the map window is not the full size, the "Eagle Eye" window will show the scope of the current map in a red rectangular. The "Eagle Eye" window and map window have been linked, the users can execute various kinds of browsing at the same time. Users can drag the red rectangle to the location where the users want to observe, simultaneously, the map window will display the designated area while the "Eagle Eye" window shows the full map, which truly achieves the function of map navigation.

**4.1.2 Inquiry Function:** The inquiry function of this system includes three forms: inquiry of the attribute information base on the pipeline graphics, SQL query and dynamic tips. When users select the first form of inquiry, the graphic which is

clicked by users is flashing, at the same time, the corresponding information is displayed in the form of dialog box. When users select the "SQL" function, they can choose field names, conditionals and types they want. Then the graphics and their characteristics constitute a data set, which be changed to yellow after click the button of searching. One of the characteristics for the system is the dynamic map tips function. At the bottom of the interface, users can freely select any layer and field of the pipelines, afterwards move the mouse to the desired location of the pipeline network, a corresponding information label will be automatically shown on the screen.

**4.1.3 Statistical Function:** Statistical function includes overall statistic and graphic statistic. Overall statistic function is the statistic of the whole layer, which calculates the maximum, minimum, average, standard deviation and total values based on the features of the pipeline points or pipelines. Graphic statistic is divided into three forms: circular statistic, rectangular statistic and polygon statistic. Users can freely choose one of the three forms to draw a range on the map, then select a field they want, a dialog of statistical features in the range of selected will be shown to them. In addition, the system also has a function of layer statistic, which allows users to real-time and directly read out the numbers of layers loaded in the main interface.

**4.1.4 Output Function:** This system can support two forms of output, which is convenient and fast. They are the screen output and print output.

##### 4.2 The Pipeline Network Analysis Function

Pipeline network analysis function includes section analysis, pipeline designs and the dynamic measurement. All of these functions fully reflect the superiority of using GIS technology to manage the pipeline system, which is compensatory for the traditional management models.

**4.2.1 Profile Function:** The profile analysis of urban integrated pipeline is the basic of design and management for road and pipeline planning, which is also the necessary information for engineering consulting. It is very important to draw the profile of the pipeline, because users can identify the location of the pipeline under the ground, and confirm the space connection of the pipelines. When you draw the cross-section map, firstly, the users press the left mouse button and drag an incision line, then the profile graphic is shown on the screen like figure 2. If the cut-off point is a solid circle, the data is the true value of mathematical calculation, otherwise, the data is calculated by consequence.

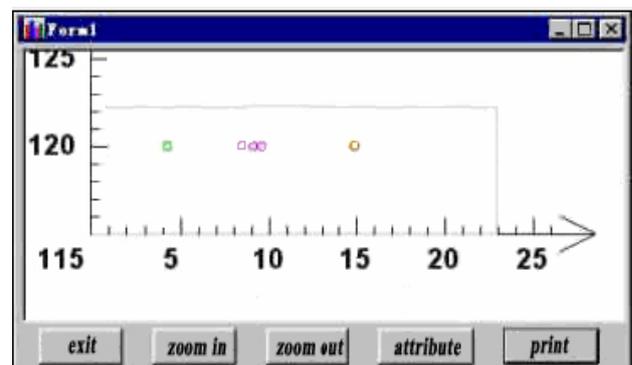


Figure.2 The map of cross-section

#### 4.2.2 Pipeline Design Function:

The pipeline design function that allows users to view the relationships of the pipelines more directly and conveniently. Users input the designed elevations of the pipelines (figure 3), press the left mouse button and drag to draw the design pipeline, then the designed section of pipelines are shown in figure 4.

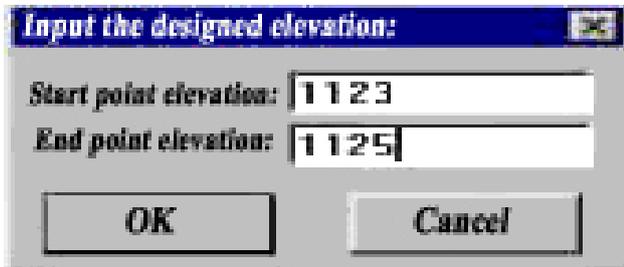


Figure 3. The dialog box of designed pipelines

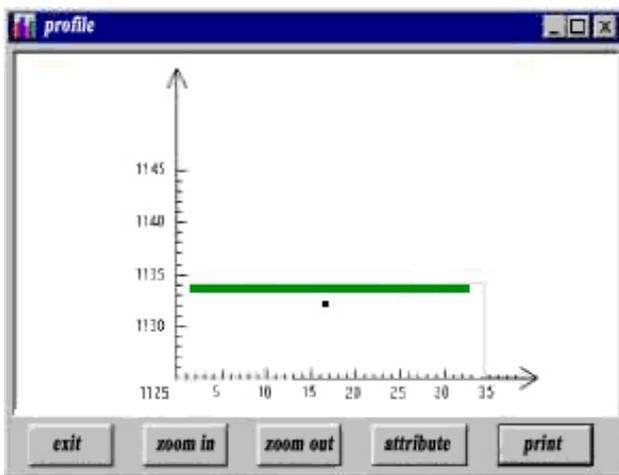


Figure 4. The diagram of designed profile

**4.2.3 Dynamic Measurement Function:** With the increasing complexity of the pipelines, the maintenance is getting more complicated. The dynamic measurement function is fit for fleetly and accurately calculating the distance from the service place to the broken pipeline when we maintain the pipelines, so we can choose the best way to maintain the broken pipelines at the first time. This function is used in pipeline maintenance, which saves time and expenses.

#### 4.3 Pipeline Network Analysis Function

This system also offers the function of editing layers and various pipeline points to users. They can change the symbols, colors and sizes of the pipeline points. The deletion of pipeline points is the function for topology checking. If you choose the function, the pipeline linked to these points which is not fit for the topology will be deleted. This function could update the attributes and parameters of the pipelines to meet the actual requirements, which expresses the advantage of GIS technology.

#### 4.4 System Security Settings

This system sets classification authorities for the different users, which ensures the confidentiality and security of data.

#### 4.5 The Main Interface

The interface is the link from computers to users. As a whole, this system has a friendly interface to all the users with small investments, and the other advantage is that users who are not the experts in GIS also could operate it expediently and fleetly. The operation effect is shown in Figure 5.

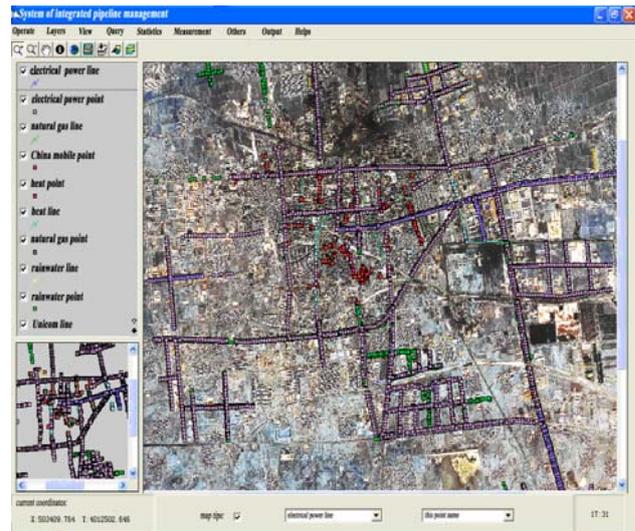


Figure 5. The map of main interface

### 5. CONCLUSIONS

In a technical view, a large number of pipeline data are processing by the means of manmade is not only inefficient but also difficult to adapt the rapid development. So it must adopt GIS technology to build the system of integrated pipeline management, which will greatly improve the efficiency, while still save a lot of human and financial resources. It is greatly significant to accelerate the development of cities; It is flexible, fast, efficient and convenient to develop the GIS based on MapObjects components. Using MO to develop system is more simple and inexpensive than using ArcGIS software separately; GIS technology is a high-technological tool, which is introduced to the management of small and medium cities. The system of integrated pipeline network has abundant reference value for the similar system. It will run more efficiently and conduct more smoothly day by day.

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