# 燃气管网爆管分析模型研究

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【摘 要】本文根据燃气管网特点分析了其网络模型，并提出了改进的网络追踪算法，而且用一种简单方法建立了可以实现一些高级功能的爆管分析模型，即在燃气管网发生爆管后，通过该模型可以及时、准确地搜索出停气调压器、关闭阀门以及停气用户等信息，从而对爆管处及时、准确地维修和对整个有影响的管网进行合理地调度提供了有利的技术支持。

【关键词】燃气管网；爆管分析；地理信息系统（GIS）；模型
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## 1 引言

随着城市建设迅速发展，各地供气企业输配气管道由于日益错综复杂而频频发生爆管，燃气一旦泄漏可能造成人员伤亡和财产损失[1]。由于燃气输配系统的复杂性，许多城市已经将地理信息系统（Geographic Information System，简称 GIS）广泛应用于燃气管理中[2]，实现了对图纸资料、设备台帐资料的一体化，提高了工作效率。那么利用 GIS的分析功能来高效和准确地搜索出停气调压器、关闭阀门以及受影响用户等信息，从而实现对爆管处及时、准确的维修和对整个有影响的管网合理的调度显得尤为重要。

然而，目前大多数燃气管网 GIS系统功能单调，仅停留在基本的空间资料查询检索和基于设备台帐的统计分析，而空间分析等高级功能普遍较弱[2]，究其原因是国内外对地理网络模型的研究，侧重于各种管线（燃气、电信、电力、给排水、热力等）高度抽象的统一网络模型研究，没有充分考虑行业特点以及在这些行业特点之上的各种特殊高级分析功能。燃气网络由于其特殊性，必须在统一的网络模型基础上，加入燃气行业的技术特点，合理简化、概括、抽象出易于计算机处理并切合燃气网络实际的网络模型、基本理论模型以及分析模型，从而扩展和加强了燃气管网 GIS高级分析功能[2]。本文主要讨论了在燃气管网的网络模型和改进的基本网络追踪理论模型基础上，提出了用来实现燃气管网 GIS高级分析功能的爆管分析模型。

## 2 燃气管网的网络模型

燃气网络是由边（Edge）和结点（Junction）的二元关系构成的系统[3]，整个燃气网络系统由各种型号的输气管线（线状设施）和用户、调压器、阀门、供气站等（点状设施）组成。根据实际的燃气管线、设备在网络模型中的作用与性质，将其抽象为链、结点、障碍、拐点和中心等[2-4]，其中像调压器这种设备在实际的燃气网络中既可抽象成障碍又可抽象成中心，那么在燃气网络模型中要特别处理，另外，燃气网络的边有压力级别，并且不同压力级别的边通过调压器进行连接从而不同压力级别的网络在整个燃气网络中是有方向的。

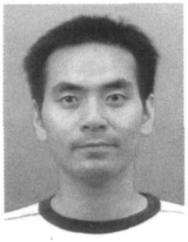
燃气管网根据计算机识别的抽象层次表现为物理网络、几何网络和逻辑网络。其中物理网络是现实燃气网络的模拟，几何网络模型是描述地理要素的形状、空间位置、空间分布以及空间关系等信息。逻辑网络是在几何网络概念模型的基础上，用计算机能够识别的形式化语言来定义和描述现实世界的地理实体、现象以及相互关系。即每一个几何网络均对应一个逻辑网络，它是一个幕后的数据结构，存储边线和结点的连接拓扑关系[5]。

一般说来，网络在数学和计算机领域中被抽象为图的概念，因而图论与管网拓扑结构图之间有着很自然的联系。建立逻辑网络模型拓扑关系实际上就是在逻辑网络模型的基础上抽象出无向图，然后生成管网参与进行爆管分析的所有点状要素之间的拓扑邻接关系。将燃气管网记为 G=(V, E)，其中 V为管网中的参与进行爆管分析的所有点状要素，称为顶点集，如用户、阀门、调压器等；E为管网中所有管段，称为边集，如不同压力级别的管段。其中图可采用邻接矩阵、邻接表、邻接多重表等方法表示[6]。

## 3 基本理论模型

网络追踪的算法主要有将网络抽象成图进行深度优先遍历搜索和广度优先遍历搜索两种算法。图的广度优先遍历搜索算法类似于树按层次遍历的过程。假设从图中某顶点 v出发，在访问 v之后依次访问 v的各个未曾访问过的邻接点，然后分别从这些邻接点出发依次访问它们的邻接点，并使“先被访问的顶点的邻接点”先于“后被访问的顶点的邻接点”被访问，直至图中所有已被访问的顶点的邻接点都被访问到[6,7]。

但是燃气管网中各种设备千差万别，在遍历追踪的过程中不能单纯的按照图的一般遍历算法进行追踪。如在燃气管网中追踪到阀门或调压器时，程序是否继续向下遍历搜索要根据系统的追踪条件实际情况来进行处理，所以需要对基于通用网络模型的遍历搜索算法进行改进。具体的处理方法是：对于在广度优先遍历搜索算法，在搜索顶点 v的邻接点中加入判断搜索的结点是否是特殊结点和追踪的路径是否符合追踪路径条件；对于深度优先遍历搜索算法的处理类似。因此，在燃气管网 GIS系统的网络追踪分析中利用这一改进的追踪模型，可以解决一般通用 GIS平台系统中对所有类型结点都一样处理的缺陷，即可以根据各类实际停止追踪条件灵活地进行追踪到燃气管网中各种类型的设备结点。



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## 4　爆管分析模型

燃气管网中爆管分析是在当前管网某处发生爆管时，首先，根据爆管现场分析模型分析出当前管网爆管后的停气用户、受影响的用户、停气调压器以及连通调压器等现场情况，这样对当前爆管的影响大小有一个合理判断。其中，连通调压器是指对于燃气用户来讲，它有两个以上的调压器对其供气，如果其中的一个调压器停气，不会造成该用户停气或该用户用气受影响，那么这些调压器就是一组连通调压器。其次，为了对现场事故进行抢修，需要通过关阀搜索模型分析出需要进行关闭的阀门或调压器，以及由此所带来新的停气用户、受影响用户、停气调压器以及连通调压器等情况信息，以供调度人员参考进行调度决策。下面是对这两种分析模型进行论述。

### 4.1　爆管现场分析模型

根据当前管网分布状况进行爆管现场分析的简易流程模型如图 1所示。具体分析流程模型如下：

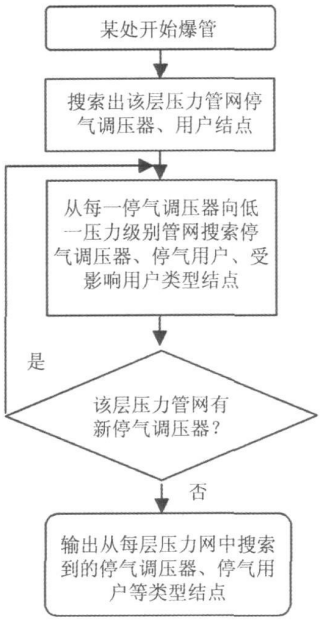


图 1　爆管现场分析模型

1）当燃气管网某处发生爆管后，利用网络追踪算法搜索出该压力层管网的停气调压器、停气用户类型的结点。其中进行网络追踪的条件是当追踪到调压器结点时不往下继续追踪，并且搜索出的调压器结点如果与当前压力管网高一压力级别管网相连就不予考虑。

2）从每一个停气调压器出发，利用网络追踪算法向该调压器低一压力级别管网搜索出新的停气调压器、停气用户、受影响用户类型的结点。其中进行网络追踪的条件是当追踪到调压器结点时不往下继续追踪。

3）判断每一压力级别层的管网是否有新的停气调压器类型结点产生。如果有新调压器类型结点产生，则转入到 2）继续处理；如果没有新调压器类型结点产生，则直接转入到 4）进行处理。

4）输出在每一压力级别层管网所追踪到的各种类型结点。

通过该分析流程模型可以很好的将爆管后的停气用户、受影响的用户、停气调压器以及连通调压器等现场情况快速的搜索出来。

### 4.2　关阀搜索分析模型

在爆管发生后，需要对现场事故进行抢修，因而需要进行合理的关阀搜索分析处理，其分析的简易流程模型如图 2所示。具体分析流程模型如下：

1）当燃气管网某处发生爆管后，从爆管处两端出发，利用网络追踪算法搜索出该压力层管网的停气或关闭的调压器、阀门类型结点。其中在该路径上追踪到的调压器、阀门、用户是停气调压器、阀门、停气用户。

2）若从爆管处两端出发追踪，没有搜索到阀门，则直接转入 5）处理；如果有则转入 3）处理。

3）判断是否有阀门失灵，如果有阀门失灵则转入 1）处理，进行扩大搜索出停气或关闭的调压器、阀门。如果没有阀门失灵则转入 4）处理。

4）从每一阀门出发，向未追踪过的路径方向追踪出停气调压器和停气用户类型结点。

5）从每一个停气调压器出发，利用网络追踪算法向该调压器低一压力级别管网搜索出新的停气调压器、停气用户、受影响用户类型的结点。其中进行网络追踪的条件是当追踪到调压器结点时不往下继续追踪。

6）判断每一压力级别层的管网是否有新的停气调压器类型结点产生。如果有新调压器类型结点产生，则转入到 5）继续处理；如果没有新调压器类型结点产生，则直接转入到 7）进行处理。

7）输出在每一压力级别层管网所追踪到的各种类型结点。

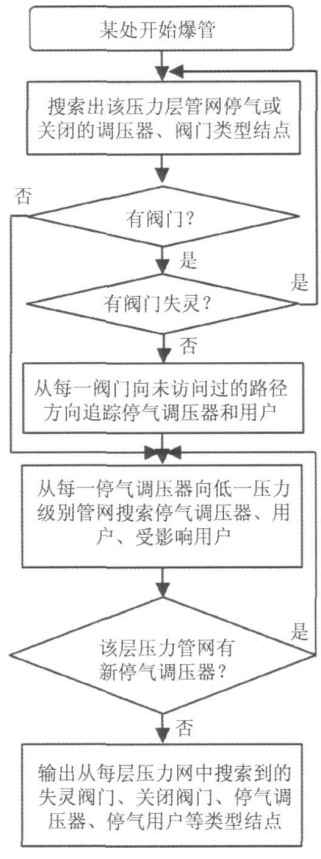


图 2　关阀搜索分析模型

通过该分析流程模型可以很好的将需要进行维修处理时的关闭阀门、失灵阀门、停气调压器、停气用户、受影响用户以及连通调压器等处理情况快速的搜索出来。

## 5　结束语

目前，通过建立网络模型、网络追踪的基本理论模型以及爆管分析模型的燃气 GIS系统，实现了燃气管网某处发生爆管后，快速准确地追踪、分析出当前管网爆管后的停气用户、受影响的用户、停气调压器以及连通调压器等现场情况信息；另外，如果需要进行关阀搜索处理，该系统可以快速准确地追踪分析出关闭阀门、失灵阀门、停气用户、受影响用户、停气调压器以及连通调压器等情况信息。这样极大拓展和加强了燃气管网 GIS系统的高级分析功能，因而也提高了事故快速修复能力，将影响和损失降至最低，提高燃气管网的现代化管理水平。

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UO polycyclic constitution locates between yaluzangbu river suture zone and the southern suture of bangongshu-nujiang suture zone, duosang fault tuough and yare fault trough. People usually think that ANGLARENCUO polycyclic constitution is built under the squeezing between India plate and Eurasia plate. On the background of Tibet uplifting, the lithosphere is squeezed by south-north compression force and is tension-thined by the east-west pulling force which strengthens the activity of the extension fracture and the frequency of the magma activity. Then ANGLARENCUO polycyclic constitution is formed.

Key words: remote-sensing technique; polycyclic constitution; fault trough; ANGLARENCUO; Tibet

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## Study on the analysis model of pipe burst for gas pipe-network

Abstract: The paper analyses the network model of gas pipe network based on its characteristics and it puts forward an improved algorithm of network tracing. Furthermore, an analyzing model of pipe burst is set up, which implements some advanced functions in a simple way. The information such as suspended boosters, closed valves, users cut off the gas supply and so on, can be exactly searched in time by the model after the gas pipe bursts. So the model provides favorable aid of technology for the pipe repaired exactly and in time on the position of burst and rational scheduling for the whole influential pipe network.

Key words: gas pipe network; analysis of pipe burst; geographical information system (GIS); model

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## Construction of Chongqing GPS integrated service system (CQGISS)

Abstract: This paper not only analyses importance and necessity of construction of ChongQing GPS Integrated Service System (CQGISS), but also gives feasibility analysis of CQGISS by GPS Combined with Present and future situation of Chongqing, it conceives the construction of dynamic spatial base frame. The organization and construction of CQGISS are discussed. According to test result, the feature and next plan of this system are proposed.

Key words: global positioning system; network real-time kinematic positioning; reference station; multi-protocol label switching; master-auxiliary correction

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## Analyses on temporal-spatial traits of land use in three gorges during 30 years

Abstract: Based on MSS data in 1975 and Landsat TM data in 1987, 1995, 2000 and 2005, the land use change in the reservoir area of three gorges is conducted and several indexes to reflect the temporal-spatial traits during 30 years are discovered. It is showing that the areas of cultivated land, forestry land and grass land have been decreased while the areas of construction land and water have been increased during last 30 years. With combination of several feature indexes, the land use change trait of three gorges is understood, which is helpful for the land planning in reservoir area of three gorges and can provide reference for ecological environment protection.

Key words: land use; traits of landscape; ratio of land use change; land use extent; Reservoir Area of Three Gorges

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## The analysis of the surveying control network in the central line setup of the south to north hydro project

Abstract: This paper will introduce the surveying control network in the Central Line Setup of the South to North Hydro Project (Central Line Project). It will present the key points and the difficult points in the project. Additionally, this paper will give some suggestions on the surveying work in the Project, to gain experiences in the long distance surveying projects.

Key words: Central Line Project; surveying control network; control surveying

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## Analysis of the land use spatial pattern and spatio-temporal changes in the area of Longkou based on DEM

Abstract: Taking Longkou city for example, from the factors of elevation, slope and slope aspect, the authors study the spatial pattern and spatio-temporal changes of four typical land use classes, which are cultivated land, garden plot, woodland and construction sites. The research shows that from 1989 to 2005, the total area of cultivated land is reducing, but its distribution is mainly in the low level terrain. The area of garden plot increase considerably and its spatial distribution has the trend to spread to higher terrain, which shows that garden plot has strong adaptability to all terrain factors. Woodland mainly distributes in the area of large regional land slope, which helps to control soil erosion. The construction sites are on the whole not restricted by terrain and its distribution is mainly the result of human activity, so its change is not obviously on terrain levels. Quantitative analyses of the index and the parameters of land use spatial pattern will help to optimize the structure of land use, achieve the rational distribution of land use on different terrain and promote regional sustainable development.

Key words: digital elevation model; land use; terrain factor

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## Study on the dynamic change of land use of Pingdingshan city based on RS

Abstract: As a representative resource-typed city, Pingdingshan city is one of the most strongly areas that the human and the land interact each other. It is also the most characteristic area that land use changed sharply. Therefore, based on the RS images of TM and ETM+ of the downtown in 1994 and in 2002, the land use information in different period is extracted, land use transformation matrix is calculated, and the spatial-temporal character and the changed law in the land use is revealed. At the same time, based on land use area change, dynamic degree, exhaust degree, exploitation degree, the land use change is studied. The study result indicates that the coal mining and the development have done an important influence on the land use change of Pingdingshan city. During last 8 years, the area of cultivated land and the wood land had decreased greatly, however the urban land, the industry and mining land and the weed land had increased greatly. The decreased cultivated land were mostly translated to urban land, industry and mining land and weed land, and the decreased wood land was mostly translated to weed land. Because of the limitation of north mining area condition, the city expanded to the east, west and north.

Key words: land use change; RS; Pingdingshan city

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## The research on the urban group in Jiaodong Peninsula based on fractal theory

Abstract: Urban group is complicated nonlinearity system which has the characteristic of self organization and self similarity. Fractural theory has became a hotspot in current city geography studies for it can well reveal current situation and evolvement law of urban group. Fractal theory was used to analyze urban system in Jiaodong peninsula from urban scale and structure. Influenced by mountainous land form, the urban structure and distribution of cities are loose. Then some suggestions are put forward on developing the urban system.

Key words: Jiaodong peninsula; Urban group; fractural

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## GIS-based spatial analysis of tourism resources in Yantai-Weihai region

Abstract: In this paper, the structural and spatial distribution of tourism resources in Yantai-Weihai region were analyzed based on GIS. The buffer analyses were taken to analyze the spatial distribution of tourism resources focusing on Yantai, Weihai and Penglai cities which were the most important tourism cities in the region, with the largest buffer radius of 30km and the interval of 5km so as to illustrate the spatial distribution of tourism resources and the space distance to scenic spots accessible. The buffer analyses were also taken to provide the spatial information of the accessible scenic spots for self-driving travelers, focusing on three important roads in the region with the largest buffer radius of 8km and the interval of 2km. Based on the comprehensive analysis, the spatial distribution features of tourism resources in the region was summarized, exploitation