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Application and Realization of Hierarchical Network Planning Based on Web

□ **WU Shi-jing, GONG Zhi-bo, YIN Yong, HUANG He-chao, LOU Wei-hua**

College of Power and Mechanical Engineering, Wuhan University, Wuhan 430072, Hubei, China

Abstract: Making use of Microsoft Visual Studio, NET platform, hierarchical network planning is realized in working procedure time-optimization of the construction by TBM, and hierarchical network graph of the construction by TBM is drawn based on browser. Then the theory of system realization is discussed, six components of system that can be reused are explained emphatically. The realization of hierarchical network planning in Internet provides available guarantee for controlling rate of progress in large-scale or middle-sized projects.

Key words: Web; network graph; hierarchical network planning

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Biography: WU Shi-jing (1963-), male, Professor, research direction: equipments management engineering, mechatronics, state monitoring and malfunction diagnostics of machine and electronics equipments. E-mail: sjwu@wuhee.edu.cn

0 Introduction

Network planning technique is a basic means of progress control in engineering management and is used to plan and control project in a part of projects and good effect is obtained. Although the network planning theory is very mature, its application in actual engineering management still needs to be enhanced. The basic principle of network planning technique^[1] is that making use of network form and mathematics operation sequence and correlation of various works in a plan are expressed, and total periods of plan is obtained and key path of it is found by calculating time parameter, and then according to prescriptive target network planning is improved continually for satisfying the decided restriction, and finally the superior project is chosen and put in practice. The substance of hierarchical network planning^[1] is that network planning is managed and established independently in different layers, and then network planning of each layer is put together for analysis. Hierarchical network planning has plenty of advantages such as simplified establishment of work, smaller subordinate network graph, convenient scene use, essentially invariant logical connection of working procedure, simple adjustment, less workload and superior network graph is displayed in different layers and is clear to understand.

The thought of hierarchical network planning is firstly expatiated in the literature^[2]. Its core is that according to different targets of maintenance and principals the series that is different from magnitude are divided and different contents of maintenance scheduling are reflected respectively. And two kinds of methods used to establish plan are put forward. One method is from top to bottom. That is to say, firstly according to holistic arrangement of superior, holistic controlling

network is established, and then based on holistic network, working procedure is decomposed hierarchically, and finally according to task target disposed by superior, junior established detailed sub plan. Another method is from bottom to top. That is to say, firstly idiographic network planning is established from grass roots, and then based on it working procedure is merged or extended. In the literature^[1] network planning technique is applied to maintenance scheduling management, the thought of multilevel nesting network planning is put forward and corresponding software is developed to realize distributed maintenance scheduling management system of multilevel network planning based on Internet.

In the article establishment of plan is from top to bottom, the application of hierarchical network planning is displayed by plenty of visualized graphs and the key technique of system realization is expatiated.

1 Application of Hierarchical Network Planning

The research background of the project is maintenance scheduling information management system of power plants^[1,3,4]. The application background of the project is working procedure time-optimization of the construction by Tunnel Boring Machine. Working procedure of the construction by TBM is excessive and their logical relation is complex. So finding key path and maintaining parallel and stagger task at the same time is the key of TBM speediness boring in the process of the construction by TBM. Network planning is divided to three grades. A project is made up of several tasks. A task is made up of several working procedures. A working procedure is made up of several sub working procedures. The principals of all levels are respectively responsible for task, working procedure and sub working procedure.

The process of planning establishment is displayed in Fig. 1.

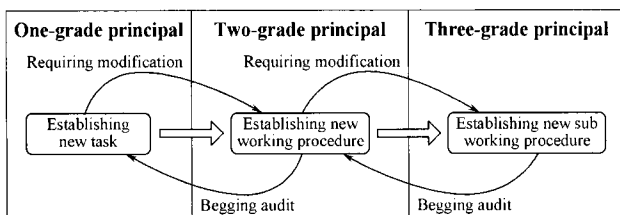


Fig. 1 The process of planning establishment

Firstly, Fig. 2-5 one-grade principals log on system and establish new project, and then task is established and task name, time and preceding task is input. After calculating time parameter of task, the transverse-line graph of one-grade (in Fig. 2), the single-node graph of one-grade (one-layer) (in Fig. 3) and the double-node graph of one-grade (one-layer) of project were obtained. We can see Secondly, Fig. 6-10 each two-grade principal logs on system and establishes new working procedure included by each task, and then working procedure name, time and preceding working procedure is input. After calculating time parameter of working procedure, the transverse-line graph of two-grade (one of them is displayed in Fig. 9), the single-node graph of two-grade (two-layer) and the double-node graph of two-grade (two-layer) of project were obtained. Here the single-node graph of one-grade (two-layer) (in Fig. 6) and the double-node graph of one-grade (two-layer) of project were obtained after one-grade principals logging on system. Lately, each three-grade principal logs on system and establishes new sub working procedure included by each working procedure, and then sub working procedure name, time and preceding sub working procedure is input. After calculating time parameter of sub working procedure, the transverse-line graph of three-grade, the single-node graph of three-grade (three-layer) and the double-node graph of three-grade (three-layer) of project were obtained. Here the single-node graph of one-grade (three-layer) and the double-node graph of one-grade (three-layer) of project were obtained after one-grade principals logging on system, also the single-node graph of two-grade (three-layer) (one of them is displayed in Fig. 10) and the double-node graph of two-grade (three-layer) of project were obtained after each two-grade principal logging on system.

Because of the limited article length, additional four graphs of project are only displayed: Fig. 4 is bitmap file (.bmp) of the single-node graph of one-grade (one-layer) that is saved and then is opened, Fig. 5 is bitmap file (.bmp) of the double-node graph of one-grade (one-layer) that is saved and then is opened, Fig. 7 is bitmap file (.bmp) of the single-node graph of one-grade (two-layer) that is saved and then is opened, Fig. 8 is bitmap file (.bmp) of the double-node graph of one-grade (two-layer) that is saved and then is opened.



Fig. 2 The transverse-line graph of one-grade

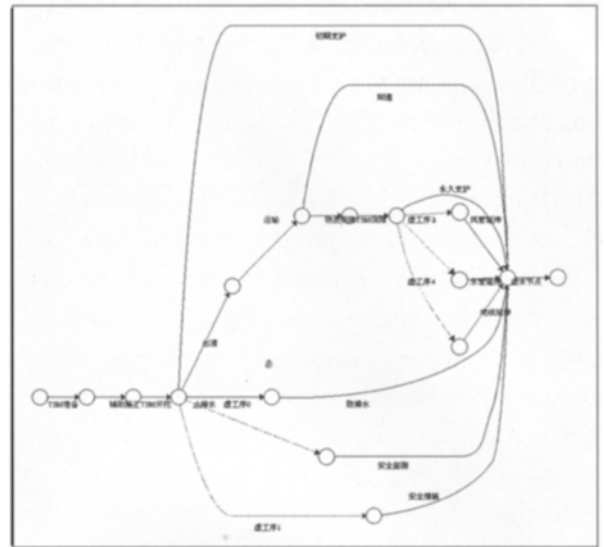


Fig. 5 The double-node graph of one-grade (one-layer)

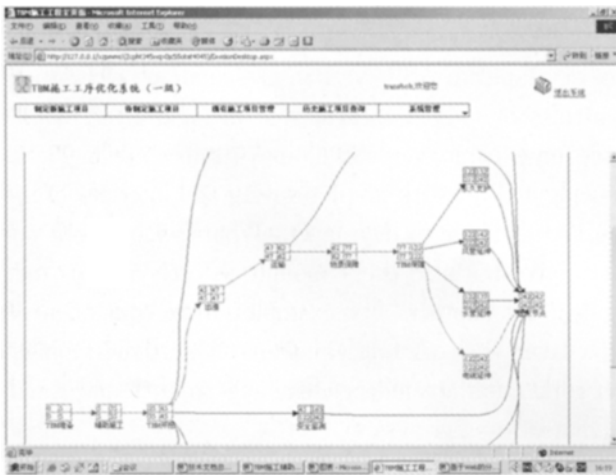


Fig. 3 The single-node graph of one-grade (one-layer)

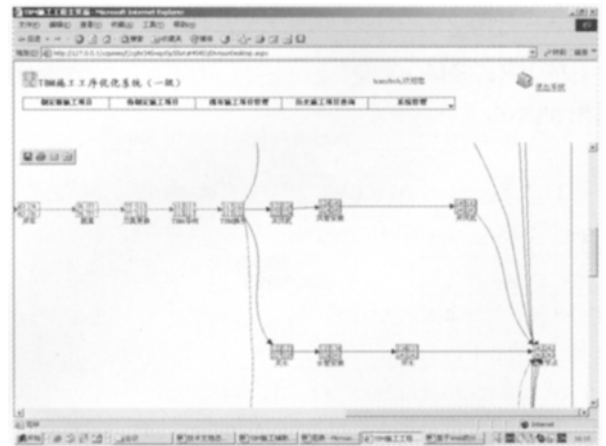


Fig. 6 The single-node graph of one-grade (two-layer)

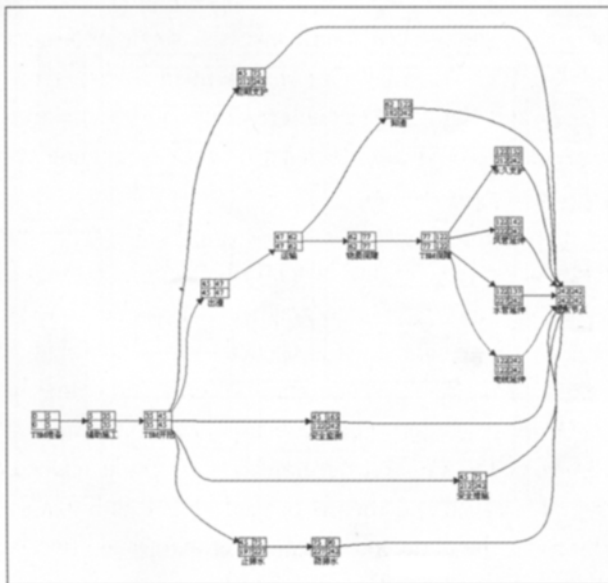


Fig. 4 The single-node graph of one-grade (one-layer)

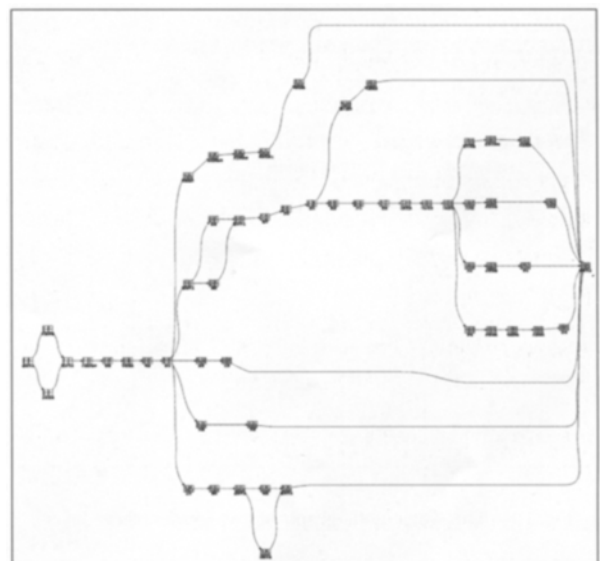


Fig. 7 The single-node graph of one-grade (two-layer)

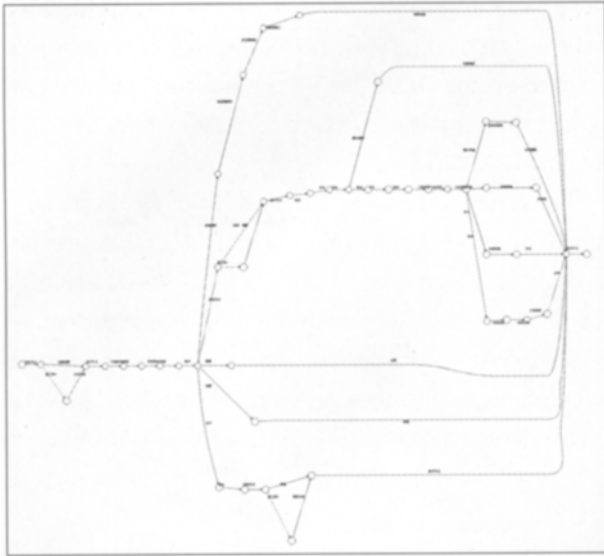


Fig. 8 The double-node graph of one-grade (two-layer)

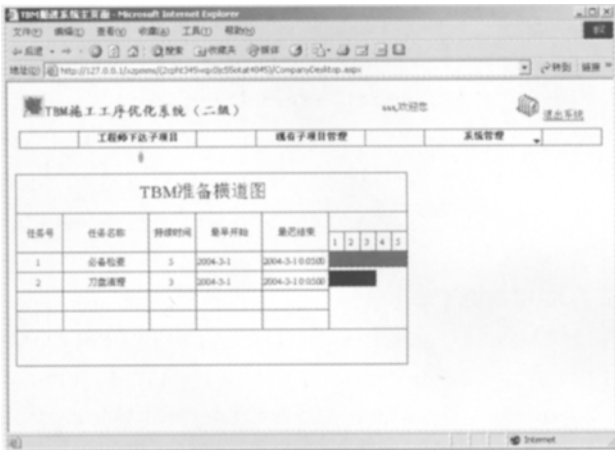


Fig. 9 The transverse-line graph of two-grade



Fig. 10 The single-node graph of two-grade (three-layer)

2 Architecture of System

Some knowledge is required in the process of developing system, such as programming in VC, programming in ASP.NET, programming in VB.NET, network programming and SQL Server database system. What is more, standard template library that can simplify programming in VC and COM component is used in the process of developing the component of TaoGraph.

Three layers architecture is adopted in the process of developing system (in Fig. 11), namely presentation layer, logic layer and data layer. By independently developing in each layer and each module, way of thinking is clear, and modification is convenient, and maintenance is handy. Many modules are developed, such as user interface developed in ASP.NET in presentation layer, operation rules of system encapsulated in logic layer that include time parameter calculation, transverse-line graph drawing and network graph drawing and interface of system and database in data layer. What is more, not only every layer but also every module in each layer is independent one another. For example, three components in logic layer such as CalcTimePara, GanttBarGraph and NetworkGraph are independent one another and can be explained to other system.

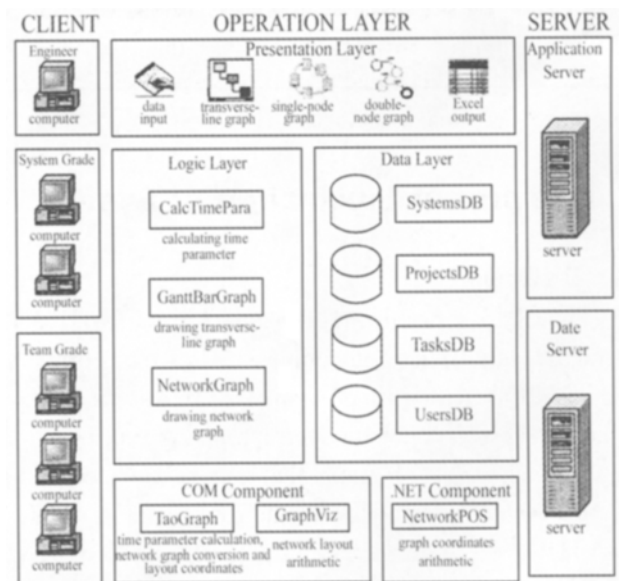


Fig. 11 The architecture of system

3 Automatic Drawing Principle of Graph Layout

Automatic layout function of graph is one of key function of system. Automatic layout of graph is very complex. The difficulty is that layout of node and arc is not a problem of mathematics parsing but varies with individual aesthetic feeling. So computer researcher is finding the excellent layout arithmetic for the excellent layout arithmetic that is recognized is not available at present.

The arithmetic library provided by AT&T Bell Lab is used in the system. Its primary aim is that layout is evenly and the number of the arc junction is smallest. Its detailed explanation is in the literature^[5]. Network layout arithmetic problem of graph is introduced in www.research.att.com. Source code developed in C on Unix platform is provided by AT&T Bell and now someone in Taiwan translated the arithmetic into the component of WinGraphVIZ on Windows platform. So Boost Graph Library and WinGraphVIZ that is external arithmetic library is used in the process of developing system. The documents and source code of Boost Graph Library can be downloaded from web station.

Entire graph can be created by four processes^[1]: firstly information of a graph is obtained by adjacency matrix, secondly the adjacency matrix is transformed to the format of dot by the component of TaoGraph, thirdly the text of dot is transformed to idiographic coordinates text of graph by the component of WinGraphVIZ, lately the graph is created.

4 Component Elucidation of System

4.1 TaoGraph

The COM component is developed in VC. NET and all source code exist. The component has three primary functions: Calculating time parameter, transforming single-node graph to double-node graph and outputting layout character string of graph that can be transferred to obtaining layout coordinates by the component of WinGraphVIZ.

The component has three common methods. AddTask(struTask * Task) is used to add information of task that is obtained by the framework of struTask. DelTask(struTask * Task) is used to delete information of task that is also obtained by the framework of stru-

Task. ComputeTime(void) is used to calculate time parameter of task. The task network must be reasonable, namely not being able to be vacant and circle network and only having one initiatory node and one end node.

4.2 WinGraphVIZ

The COM component is part of layout coordinates arithmetic library of network graph and makes use of a standard graph language of dot to draw graph whose detailed syntax is in the literature^[6]. The component has two primary functions: inputting layout character string of graph and outputting coordinates of node. The up to date installation program of WinGraphViz can be downloaded from home.so-net.net.tw/oodtsen/wingraphviz/index.htm.

4.3 NetworkPOS

The .NET component is developed in .NET and parses coordinates text obtained by WinGraphViz. That is to say, it parses character string compartmentalized Graph, Node and Edge and then saves as common variable. It is discussed in detail in the literature^[6].

The component has one common method. ParseNetworkGraph(ByVal strGraph As String) is used to parse data sent and save as m_CanvasSize, m_NodePos and m_ArcPos.

4.4 GanttBarGraph

The .NET component is used to draw transverse-line graph and its principle is relatively simple. Frame, title, list, rectangle graph part and bottom label of graph are respectively drawn.

The component has two common methods. FillStructBars2(ByVal DataSet1 As DataSet, Optional ByVal bDepended As Boolean = True) is used to obtain information of task. Input parameter is DataSet namely data aggregate of task. Draw() is used to draw transverse-line graph.

4.5 NetworkGraph

The .NET component is used to draw single-node graph. It calculates coordinates of node by the component of WinGraphViz and then adds information of task. It is very flexible. User may directly modify many properties because their settings are common, such as title, page size and color of node, arc and key path.

The component has two common methods. FillNetwork(ByVal dataset1 As DataSet) As Boolean is used to obtain information of task. DataSet includes two datasheet; task and relationship of task that must be checked up and satisfy two conditions. Firstly Task network must be

unilateral namely and not be circular. Secondly it must be single initiatory node and single end node and not be two or three initiatory node and two or three end node. Draw() As Bitmap is used to directly draw single-node graph after obtaining information of task.

4.6 DNetworkGraph

The .NET component is used to draw double-node graph. Its principle is same as the component of NetworkGraph. Difference of them is that task is expressed by arc and includes virtual working procedure in the component of DNetworkGraph.

The component has two common methods. FillNetwork(ByVal dataset1 As DataSet) As Boolean is used to obtain information of task. DataSet includes two datasheet; task and relationship of task. Draw() As Bitmap is used to directly draw double-node graph after obtaining information of task.

5 Database Elucidation of System

SQL Server 2000 database management system is used in the system. Besides datasheet, relation graph, storage process and in-line trigger is applied and these functions can simplify development of system. Provided that a task will be deleted, other datasheet that is correlative with the task must be deleted after deleting corresponding information of task. If trigger or data restriction is not used, not only plenty of code must be compiled in .NET and additional measure must be adopted to ensure the right of logic connection. But trigger is used, above tasks can be conveniently and safely completed by less code.

6 Conclusion

How to deal with interface of historical data and current database is the key problem of realizing share of data, and the quality of the solution is concerned with successful generalization of the system. At present function of security already basically met demands and controlling of jurisdiction is also realized. But some work still need be done for further improving security, such as registering operation process of user; what is added and deleted, when do users log on and quit.

According to experience of developing, operation sentence to database ought to be encapsulated at full steam in the process of programming. Making use of logic layer and data layer, idiographic database operation ought to be shielded. And this incarnates thinking of software engineering namely high cohesion and low coupling.

Emphasis of development is comprehension and improvement of arithmetic component and is not interface of existing system. Because requirement of user may change and interface of existing system can be push over to do it again, and then code of interface need be developed over again according to requirement. But arithmetic component that is the key of entire system always may be reused.

Tribute; Base on the software developed by Yin Yong, Lou Wei-hua and Huang He-chao^[1,3,4] the system can be established. Thanking them for the jobs that they have done, especially the components that are mutually independent and can be reused. What is more, Thanking Hu Jian-zheng and Zhang Ming-yan for translating and proofreading the article.

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