Research of 3D digital mine ventilation system based on frame/plug-in technology

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Abstract:

Mine ventilation system is critical for maintaining safe working conditions in an underground coal mine. At present, there exist some problems in developing mine ventilation software such as long development cycle, redevelopment, low commercialization and weak extensibility. The traditional digital mine ventilation systems is complicated to be modified or extended after published unless the programmer modify the code and recompile the software. According to these problems, this paper bring forward the design method based on frame/plug-in to develop 3D mine ventilation system, and design one frame, six function plug-ins and four layer plug-ins. That is, routine management plug-in, 3D laneway modeling plug-in, 3D display plug-in, ventilation network solution plug-in, fan performance test plug-in, ventilation resistance test plug-in, laneway layer, fan layer, construct layer and flow direction layer. The plug-ins can plug and play so as to improve development efficiency and quality as well as reuse ability to reduce software usage cost.

Key Words: Frame, Plug-in, three dimension, Digital ventilation system

0 Introduction

Mine ventilation is a very important issue to ensure safe mine production and promote modernization of the mining industry. In order to manage mine production more scientifically, we develop a 3D digital ventilation system according to the ventilation status of some mine. Depending on the mine ventilation theory, this system is developed using the modern frame/plug-in software development technology to store and manage information about laneway, structure and ventilation status. It also has function of ventilation network solution, three dimensional display and interactive roaming.

1 Plug-in Technique

The traditional ventilation system can't be modified or expanded after release. We must modify the code and recompile it if we want to add some new functions. Obviously this is very inconvenient, while frame/plug-in technology can solve this problem nicely.

Plug-in technology is increasingly widely applied in recent years. Its essence is to extend software function without modifying the main program (frame) by predefining a group of interfaces. Through these interfaces, the plug-ins and programs calling them are linked together. Therefore, users can write their function plug-ins and load them into the system dynamically so as to extend the original program.

As figure 1 shown, programmers write system frame firstly, and predefine the extension plots of the system. Plug-ins are extension functions written by other programmers which appear as dependent file. The frame system doesn't know the detailed function of plug-ins. When frame system starts, it looks for plug-in through the plug-in configuration, and links plug-in according to the predefined interface.

Software written with plug-in technique is easily to extend. If we want to extend the software with some

functions, we just add or modify some plug-ins and needn't recompile the whole software.

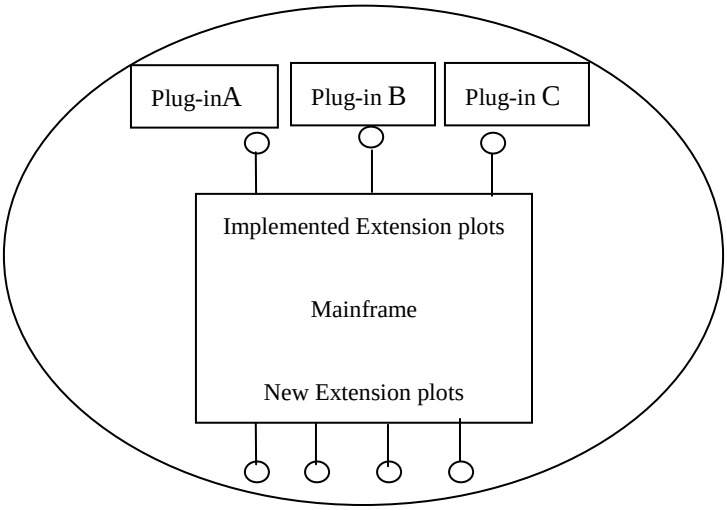

Figure 1 Sketch map of frame/plug-in

2 Software architecture design

According to the characteristic of the three dimensional mine ventilation system, this paper presents system's architecture, that is, one framework, seven function plug-ins and four layer plug-ins, just as figure 2 shown.

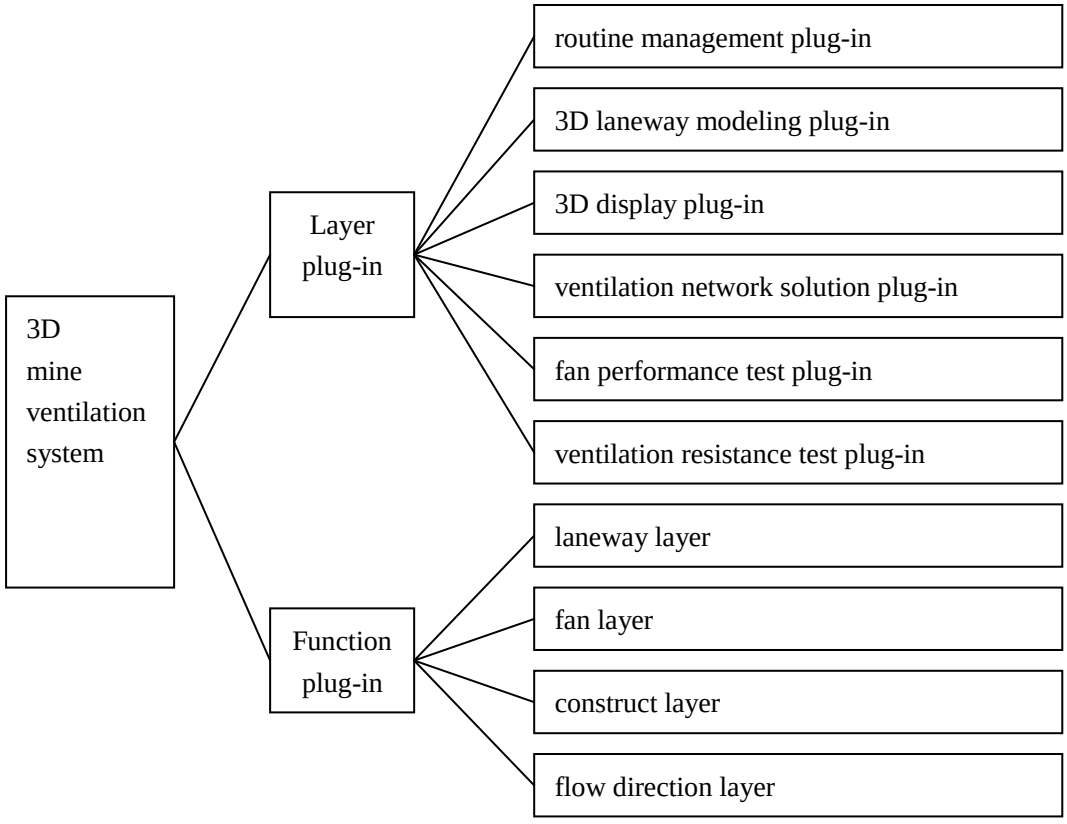

Figure 2 Architecture of the 3D digital mine ventilation system

3 Design of main function plug-ins

3.1 Routine management plug-in

There're various reports generated during mine for management. These important data mainly rely on manual before, and this is tedious, time-consuming and difficult to query. This plug-in aims to process data reports generated during mining automatically so as to simplify management and increase working efficiency.

3.2 3D laneway modeling plug-in

(1) After inputting the node coordinate and topological data of laneways, a 3D laneway simulation graph is generated as figure 3 shown.

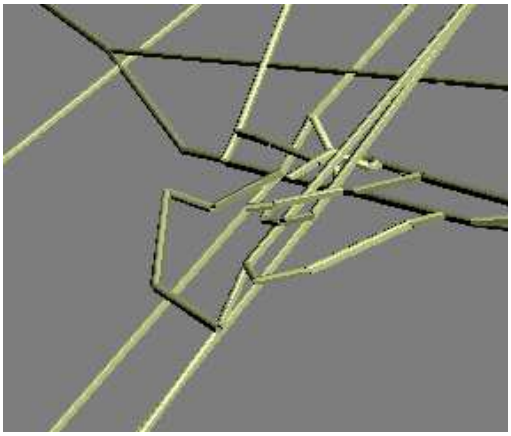

Figure 3 3D laneway simulation graph

（2）Delete a laneway: The unused laneway can be deleted after some areas are exploited over.
（3）Add a laneway: A new laneway can be added during grubbing at any time.

3.3 Ventilation network solution plug-in

Input the attribute parameters of laneways and fans, write equation arrays according to wind quantity balance law, wind pressure balance law and resistance law, then compute the wind quantity and direction for each laneway by using Scott-Hinsley method, analyze the working parameters, such as working wind quantity, wind pressure and efficiency, and output result. The detailed process is shown in figure 4.

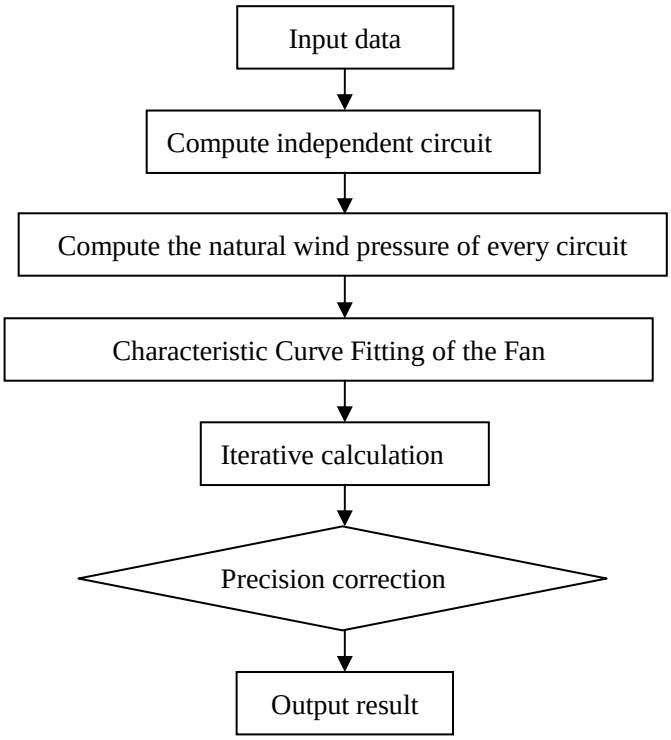

Figure 4 Flow of ventilation network solution

3.4 3D display plug-in

This plug-in offers the 3D window operation functions such as zooming in, zooming out, rotating, transferring, interactive roaming, and so on. These operations all can be used with mouse and keyboard.

3.5 Fan performance test plug-in

According to the original data, this plug-in computes the fan's characteristic parameters of wind pressure, calculates fan running efficiency so as to determine whether the fan is the best working conditions, and draw the fan characteristic curve.

3.6 Ventilation resistance test plug-in

The plug-in offers the following four main features: (1) Optimize the mine ventilation resistance measurement route, including optimizing route by only measuring trunk laneways, testing all branch laneways, as well as testing all nodes; (2) Arrange raw data; (3) Examine accuracy with the greatest/smallest resistance route closure; (4) Adjust measured values with least squares adjustment and generate coefficient matrix of the residual equations.

4 Conclusion

This paper gives the architecture of the three dimensional digital mine ventilation system with framework / plug-in technology. Practice has proved that this is a good open system design. It increased the scalability and maintainability of mine ventilation system, while users can easily assemble and extend the function plug-ins to satisfy their actual need.

References

[1] Li Suhe, Wang Yizhang. Research of Mine Ventilation Network. Beijing: China Coal Industry Publishing House, 1984.

[2] Lin Jianguang, Jiang Zhong'an. Mine Ventilation Network Solution System with Functions of Network Chart Plotting and Fan Selecting. Mining and Metallurgical Engineering, 2007(03), 20-23+27

[3] Guo Nianqin, Huang Guoping, Wang Haining. Development and Application of 3D Simulation System for the Mine Ventilation Network. China Tungsten Industry, 2005(05), 45-48

[4] Zeng Wei, Zhang Hongfu, Wang Gang, etc. Research and Application of Ventilation Network System Computation Based on WebGIS Technology. Safety in Coal Mines, 2005(08), 33-35