Application of Semantic Analysis System in Intelligent Navigation Path Planning Based on Pulse Lidar Profiler

Zhongyi Yang and Li Tao*
School of Mechanical Engineering, Jiangsu Ocean University, Liangyungang, 222005, Jiangsu, China

*Corresponding author email: 287473451@qq.com

Abstract. The daily operation and maintenance of rock tunnel and coal mine roadway focuses on ensuring safety and data validity. Although a lot of related research has been published, most of them focus on one or several categories of dangerous situation handling. This research combines the concepts of pulse lidar profiler and semantic analysis system, and proposes a new system oriented security operation and maintenance method. The scanning of the conventional area can even be skipped in the case of time constraint, but the sub key area and the primary key area must be scanned and monitored strictly according to the scanning times converted from the weight value of real-time calibration. For the primary focus area, the maximum scanning cycle of 7 cycles can be specified directly. In short, it classifies the continuous spatial point cloud data scanned by pulse lidar profiler through semantic analysis system, and allocates weights according to different classes of object mapping, and makes multiple scanning decision arrangement for high weight classes.

Keywords: Semantic analysis system; Profiler; Fog computing; Lidar.

1. Introduction
Pulse lidar profiler is the processor part of the front-end monitoring system. Semantic analysis system is the middle part of the database, with the help of each semantic sub module, it can achieve the rapid and effective scheduling of classification objects. Semantic analysis system is to solve the problem of low efficiency of project management in a large-scale system with multi objects and complex spatiotemporal relationships. The recent successful application is the overall construction and daily operation and maintenance of Dalian Road Tunnel in Shanghai, China[1]. The application-oriented research closely related to pulse lidar profilometer technology covers the case study of rapid statistics of building wood on rivers[2], 3D scene modeling[1-7], aircraft attitude control and path planning[5-7]. In all the above contents, the first problem to be solved is the 3D scene reconstruction technology based on 3D point cloud. With the accurate and reliable scene model, the crack analysis, tunnel deformation analysis and robot autonomous road planning have the basis of accurate implementation.

- As shown in Table 1, if the pulse lidar profiler carried by the robot car can maintain long-term and continuous intensive monitoring of key areas and key objects, the safety factor of both workers in the tunnel and heavy machinery will be greatly increased;
- The health condition monitoring, rock degradation, crack initiation, deformation of tunnel inner wall and top, abnormal water permeability are closely related to the safety of miners.
2. Semantic Analysis System and Its Application

The application of semantic analysis system in the industrial background is aimed at the problem that large-scale projects cannot be efficiently managed. Almost all large-scale projects have a large amount of data flow in a large number of different types of equipment, thus data and equipment classification management is imperative. And such classification and management must be concise and easy to understand, both senior engineering personnel with doctoral degree and ordinary employees with low education level can understand. Semantic analysis system is such a kind of auxiliary management system that labels the complicated data flow and various types of equipment according to their functions and properties, which is convenient for engineers to explain and communicate.

At the same time, the semantic analysis system also effectively connects heterogeneous data types. Its function is to extract core feature and attribute data effectively and accurately from various storage types of files, such as picture file, audio file, video file, TXT file, DOCX file, PDF file, database set compressed RAR package file and so on. A more significant function is that the semantic analysis system can establish the relationship mapping between the current file and other related files, so as to establish a strong and complete and systematic dynamic network of engineering state composed of object, class and relation mapping. This network structure greatly facilitates the top designer to manage the whole project efficiently.

As shown in Fig.1, Two kinds of databases are stored in the pulse lidar profiler. One is the key class database marked with red font on the left, and the other is the basic class database marked with purple font on the right. In the middle of the two, the pattern of key and lock marked in green font represents the relationship mapping between scheduling and operation between the same class and between different classes.

The relational mapping set can ensure that the dynamic operation of large-scale projects, such as unmanned underground excavation, is dynamically and accurately reflected in the daily operation and maintenance bulletin.
2.1. The Function Relation between the Weight of Key Class Database and Scanning Times
Due to the limitation of time cost, different key classes in the key class database have different weight values, and the weight values of these settings will change dynamically in different stages of the project, that is, different mining stages.
Although the weight value is dynamic, the function relationship between real-time weight value $\omega$ and scanning times $N$ is constant:

$$N = \lceil \omega \rceil$$  \hspace{1cm} (1)

In Equation 1, the general symbol $\lceil \rceil$ means rounding up.
2.2. Disposal of Different Areas according to Different Weights

See Figure 2. Because the weight of the red part in Figure 2 is the heaviest, the red area is scanned five times. The weight of the bright yellow part is smaller, so the bright yellow area is scanned twice. For extremely important and dangerous critical areas, it is strongly recommended to use the maximum number of scanning cycles of 7.

![Diagram showing key and secondary scanning areas](image)

**Figure 2.** The robot car carries the schematic diagram of the key repeated scanning area and the secondary key repeated scanning area of the pulse lidar profiler.

3. Conclusion

In conclusion, this study has made efforts to improve the unmanned mining system in China's coal mines.

The conclusions are as follows:

- The high degree of data heterogeneity of 3D objects with similar attributes and different shapes can be solved by concatenating similar objects with semantic analysis system;
- In the huge mining space, the complex space-time relationship of equipment operation;
- The top expert knowledge base system of cloud database can be used to avoid the expensive employment expenses of crisis management experts;
- For extremely important and dangerous critical areas, it is strongly recommended to use the maximum number of scanning cycles of 7.

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