Application of UAV Airborne Lidar in Transmission Line Patrol

Baofeng Liu

Yangling Vocational and Technical College, Yangling,, Shaanxi, China

sxlbf188@163.com

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Abstract: With the continuous progress of science and technology, UAV (unmanned aerial vehicle) technology has also developed rapidly. The application of UAV airborne lidar technology in transmission line patrol can solve the problems of low efficiency and high cost of manual power line patrol, and also make up for the trouble caused by unstable operability and cumbersome technology in helicopter power line inspection. This paper introduces the UAV airborne lidar system, discusses the data acquisition and processing functions of laser point cloud, and the application effect of UAV airborne lidar, realizes distance measurement and asset management, and provides a strong guarantee for better management of transmission lines.

1. Introduction

Due to the expanding trend of power grid scale, a large number of transmission lines are exposed in some poor mountainous areas, which are affected by the harsh environment. This phenomenon has brought serious damage to the transmission lines. In order to ensure the safe operation of transmission lines, it is necessary to carry out regular inspection and maintenance. However, the traditional manual inspection and helicopter inspection have some problems, such as high cost, poor operability and so on, which can't be carried out in the harsh environment, failing to provide better service for the power grid inspection work. Therefore, the application of UAV in the transmission line has changed the current situation and met the requirements of large-scale power grid patrol.

2. UAV Airborne Lidar System

As the name suggests, UAV is a kind of aircraft that can fly autonomously through remote control without human operation. Although the UAV does not carry operators, it can carry cameras and positioning systems. In addition, the UAV has the function of information transmission. Due to these functions, UAV is widely used in agriculture, surveying and mapping, emergency relief and other fields. With the rapid development of UAV, there are many kinds of UAV, which can be classified according to weight and size, as well as use, flight mode and speed. The structure of UAV system is also complex. In addition to the UAV itself, there are five other systems, including flight control system that mainly controls the take-off and landing of UAV and belongs to the core system, power system as the engine, communication system as the data transmission software and hardware, energy system that undertakes the role of providing power, task-load equipment as ground monitoring station.

Airborne lidar has the characteristics of convenient operation and high accuracy, so it plays an important role in the surveying and mapping industry. The laser scanner in the airborne lidar can automatically acquire the point cloud data in the transmission line, and can quickly and efficiently acquire the three-dimensional coordinate points of the ground object with the GPS function. With the continuous development of software and hardware technology, airborne lidar has been applied in the automatic classification of ground objects.

3. Acquisition and Data Processing of Laser Point Cloud for Transmission Line

The application of UAV airborne lidar in transmission line patrol is mainly reflected in the

collection and processing of laser point cloud data. Therefore, this paper will focus on the analysis of point cloud technology.

3.1 Laser Point Cloud Data Acquisition

First, the preparatory work should be done. Before collecting point cloud data, we need to carry out field survey and route design to carry out the following work. The main purpose of the field survey is to have a preliminary understanding of the area to be measured, such as the traffic situation around the survey area, how the topography is distributed, how much the boundary range is, and so on. In the course of route design, we must follow the efficient and economic principles [1]. Based on the results of field survey, according to the obtained topographic map, we can start from the local actual weather conditions, combine with the requirements of the demander, formulate detailed flight route of UAV within the scope permitted by the industry specification, and make perfect flight plan in advance to make reasonable arrangement and planning for personnel. With the development of point cloud data collection, flight design needs to be changed step by step. Only by keeping constant update can the quality and efficiency of point cloud data collection be guaranteed.

Secondly, we can officially start the work of data collection. After the preparatory work of point cloud data acquisition is ready, the control measurement, data acquisition and supplementary measurement should be started. The main purpose of control measurement is to establish the coordinate datum of point cloud data, and the way to establish the coordinate datum is point selecting and stone burying, data analysis, network design and measurement, etc. The data acquisition work needs to install and check the equipment, and then let the UAV test flight and climb, autonomously cruise, and finally return to landing. The purpose of equipment inspection is to ensure that the UAV can successfully complete the acquisition task when it carries out data acquisition outside. The inspection content mainly includes the inspection of the UAV's shape, accessories, functions and other aspects. In addition, it also checks the energy supply equipment of the lidar equipment. The supplementary measurement work is a kind of supplementary flight measurement work to make up for the missing flight or point cloud density that does not meet the requirements when UAV is collecting data outside.

3.2 Point Cloud Data Processing

Point cloud data processing generally includes data preprocessing, data processing and analysis.

First, data preprocessing is generally divided into the following four aspects. First, data quality inspection mainly checks whether the point cloud data meets the requirements and whether the airborne radar data is complete and accurate. The second is data conversion, converting the original data from airborne radar and ground base station into a common data format. The third is three-dimensional coordinates of UAV flight platform by trajectory calculation. The fourth is point cloud data calculation.

Second, data processing and analysis are divided into the following four aspects.

The first is point cloud denoising. During the flight of UAV, due to the material and shape of the lines, towers and surface objects in the transmission line channel, as well as the dust particles in the air, there will be some noise points on the cloud point data [2]. In addition, UAV may appear turning, deceleration and other trajectories in the process of flight. These activities will cause certain noise points to cloud point data. The noise points may have a certain impact on the classification of cloud data and the analysis of risk points. The circle is the noise point, as shown in Figure 1.
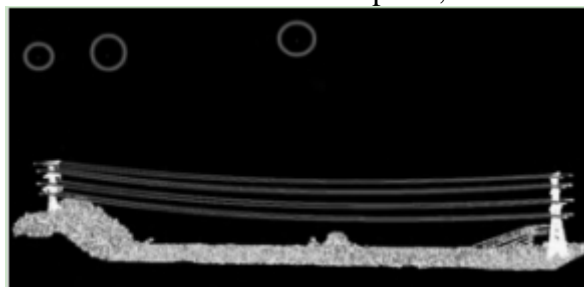
Figure 1 Point Cloud Denoising

The second is point cloud classification. In the process of data acquisition, airborne lidar can collect all the targets in the channel at one time. In order to better distinguish the diversified ground objects, and use point cloud calculation to measure the distance from different ground objects to transmission lines and the crossing distance, it is necessary to adopt the method of point cloud classification. Generally, the channel point cloud of transmission lines includes buildings, high and low vegetation, roads, towers and power lines. In order to effectively distinguish different targets, the classified point cloud can be marked with different colors, which is convenient to confirm each target. Generally, the filtering classification method is used. The effect of point cloud classification is shown in Figure 2.
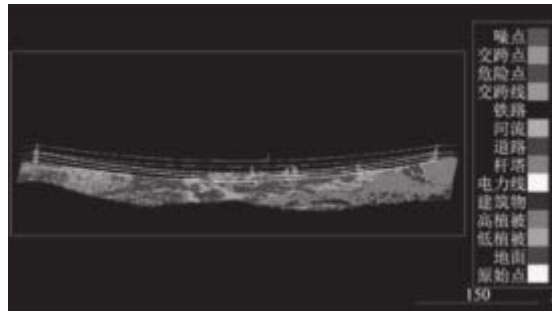

Figure 2 Effect of Point Cloud Classification

The third is risk point analysis. When calculating the distance between the wire and the ground object, the crossing distance between the wire and the wire, the results of point cloud classification can be used. At the same time, according to the requirements of the safety distance specification formulated by the power grid industry, the safety distance can be calculated, and the dangerous point level can be divided [3]. In order to facilitate the later filing, and to facilitate the inspection personnel to carry out the inspection of potential safety hazards, it is necessary to work out the risk point analysis report.

The fourth is the simulation analysis of working conditions. Because the transmission lines are located in the external environment, so they are easy to be affected and seriously damaged by external environmental factors, such as the threat and damage of storm, rainstorm, rain and snow, high temperature and so on. In addition, harsh environment is not suitable for the staff to patrol transmission lines, so it is necessary to simulate and analyze the working conditions. According to the temperature, wind speed and other factors, the change of transmission lines is simulated, and the specific situation of transmission lines is dynamically evaluated.

4. Main Functions and Application Effects of the Technology

The main effects and functions of UAV airborne lidar technology in transmission line patrol are as follows.

4.1 Main Functions

The main functions of distance measurement and line asset management can be realized by UAV airborne lidar technology. First of all, the realization of distance measurement is mainly reflected in the fact that it provides powerful reference data for the management staff of the transmission line, and it can timely find the security risks existing in the transmission line, so as to avoid the huge threat to the line caused by the external environment. Using airborne lidar technology, we can accurately calculate whether the distance of high and low vegetation, buildings, towers and other ground objects to the line meets the requirements through point cloud collection. The second is line asset management. Through the collection and classification of point cloud, we can restore the three-dimensional models of the surface shape, architecture and tower of the power line, and input these parameters to facilitate the line asset management.

4.2 Application Effect

UAV airborne lidar technology is a new technology. Appling this technology to transmission line inspection not only greatly reduces the cost of line inspection, reduces the probability of personnel's field operation, but also improves the efficiency of line inspection to a great extent. In addition, UAV lidar technology can also realize the three-dimensional reconstruction of power lines and towers, and can accurately measure vegetation and power lines, providing effective data information for managers and avoiding unnecessary losses.

5. Conclusion

To sum up, the advantages of UAV airborne lidar technology can make up for the problems existing in manual power inspection and helicopter power inspection. The application of UAV airborne lidar technology to transmission line inspection can realize the fast and accurate inspection of transmission line channel through the functions of point cloud data acquisition, processing and analysis. The application of this technology solves the problems of high cost, low efficiency and difficult large-scale inspection to a great extent, improves the work efficiency of line inspection, and reflects the important value of UAV in transmission line inspection.

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