LIDAR APPLICATIONS IN THE ELECTRICAL POWER INDUSTRY

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ABSTRACT：

For the moment the total length of Chinese powerline is at the second place of the whole world. During the Eleventh Five-Year Plan the government will enhance the construction of power grid to supply the national needs for electrical power. Therefore, how to efficiently construct and manage these long lines is an imperative problem. Based on its advantages of quickly acquiring of high precise point clouds and digital photos LiDAR technology makes the new powerline trend choosing and the checking, asset management and analysis of constructed lines more convenient than the conventional remote sensing methods.

1. INTRODUCTION

Recent years, with the fast development of Chinese economy the need for electricity increased highly, which made the construction of power grid more necessary. By the end of 2004 the powerline length whose capacity was above 110kV was about 500 thousands kilometers. For 500kV was 50 thousands kilometers. For 330kV was 12 thousands kilometers. For 220kV was 170 thousands kilometers. The whole length was the second longest in the world[1].

At the same time how to manage the constructed lines efficiently and make them work normally to transfer electricity safely became more important. Power accident would do harm to not only power grid company's profit but also the whole society.

LiDAR technology was another revolution in remote sensing after GPS. It could get high precise laser clouds and digital photos, which combined with GIS technology would be widely used in power grid construction and management.

LiDAR system involved 3D laser scanner and aerial camera. It used laser ranging and aerial photography theory to acquire big area 3D data. Its fast, few out-work, precise, high automatic and real reflection of terrain advantages made the production of DEM, DSM and DOM more quickly.

For the whole process of a new power grid construction Lidar could be used to Route design Optimization, Staking design Optimization and building. LiDAR digitalized reconnaissance, design and construction production which could support powerline 3D visualization management and professional analysis.

For the constructed power grid we could reconstruct the powerline and corridor precisely and measure the distance between terrain to powerline to find the dangerous points. Also we can use LiDAR to complete powerline 3D visualization management and professional analysis.

2. APPLICATION

2.1 Application in a new powerline

2.2 1Methods

For power grid construction the conventional process included planning, line design, staking design and construction etc. The data came from manual draw or aerial photography. Through this way the data was not visible, low precise and could not be reused. It could only suit the every process's need but could not support power gird post-construction management.

LiDAR for route design optimization included data acquiring, data processing and design optimization etc.

(1)raw data acquiring:
This included setting flight plan before taking off, installation of GPS, measuring of laser scanner, INS system and camera etc.

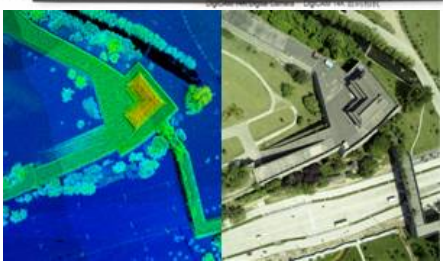


Figure 1.the LiDAR system Figure 2.point clouds and image

(2)data processing:
In order to get the needed information we need to do some process with the raw data,which included: trajectory assurance, laser data processing, data classification, coordination setting, photo orientation, DEM making.

(3)route design optimization:
According to line design's need we could optimize the route design and staking design process on the basis of precise orthophoto, point clouds, DEM and combination of 2D and 3D data.

2.2.2characteristics

(1) On the base of DEM, DSM, DOM and needed parameters we could acquire the section data automatically, quickly and efficiently.

(2) Based on the section data and real 3D circumstance we could optimize staking design. Also we could analyze powerlines' each parameters according staking coordination, staking section data and houses distribution map.

(3) The design optimization based on precise 3D scene which was made through DEM, DSM and DOM concluded route, space measurement, avoiding of landscape, farmland and building, earthwork calculation, remove calculation and so on. The optimization process was quick, exact and intelligent.

(4)LiDAR 3D production could perfectly connect with CAS system and other professional softwares to make the design of 3D staking fragment and basement more easy.

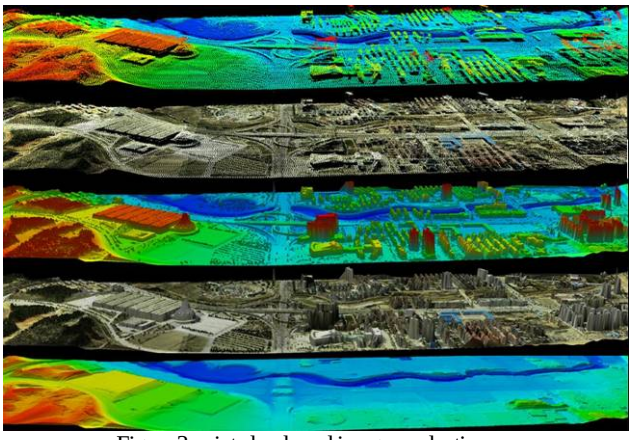


Figure 3.point clouds and image production

(5)LiDAR 3D data made powerline, circumstance, and social factors into one system, which integrated the powerline choosing, circumstance, disaster, social development and incarnated the circumstance, humanlity and social characteristics of powerline choosing.

2.2.3 digital transfer

The final data we gave clients were digital format which comprised precise terrain and staking information. The clients could input these data to their power grid management system to do after construction management which saved money for them.

2.3 Application in constructed powerlines

This usage involved powerline checking(dangerous points, distance between lines), asset management and professional analysis.

2.3.1 powerline checking

The most important work for powerline checking was to find the abnormal equipment, dangerous points and the threat to lines. Through LiDAR highly precise point clouds data we could check whether the distance between lines and building, vegetable was suitable for safety requirement. Through LiDAR highly clear pictures we could decide the equipments and channels were normal or not.

2.3.2 asset management

We could make 3D models for the powerline through DOM and DEM which were made from LiDAR laser and photo data. From these models we could tell the terrains(including trees and buildings) of the lines, the staking sites and models. That combined with electric equipment parameters we could manage the powerline asset.

2.3.3 professional analysis

Because LiDAR data were highly precise all models exactly matched with the real world. Combined with the temperature, humidity and wind speed which sent back from the inspection devices we could make kinds of professional analysis, such as the changes of lines when they under different temperature, wind speed and ice cover and trees situations, through power grid 3D model. These analysis gave decision support for lines management.

3 THE SYSTEM FOR POWER GRID MANAGEMENT

Focused on LiDAR technology's trait and the demand for electric industry we studied the relationship between GIS technology and electric industry and found solutions to use GIS in electric industry. Those were solution to power grid project(plan, reconnaissance, design, construction) and solution to power grid management(operate, management, maintain).

The system for power grid management was a software aimed at electric equipments 3D management. The data came from a new powerline or acquired from lines checking could be input into this system. For the management department they could manage all of the power grid through 3D visible models, such as query, location and analysis. That was what we called digital power grid.

4 Examples

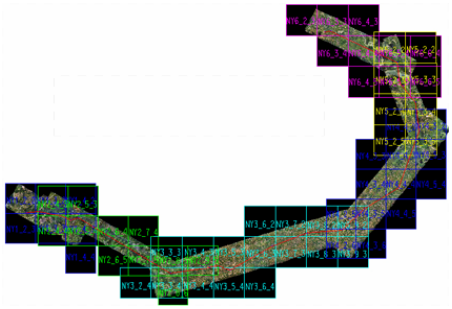
Followings were examples of LiDAR in electrical optimization and powerline checking.

4.1 route design optimization

In order to take new technology into electric industry we used LiDAR technology to optimize the design of Luoping-Baise 500kV second powerline project. This project started from Luoping 500kV substation Yunnan province and ended at Baise substation Guangxi province. The total length for the recommended solution was 286.1 kilometers.

We finished the optimization job through OnePLD system based on LiDAR data. Through the system we designed the route and staking. From total comparison the whole invest was about 7.8318 million less than the recommended solution. Also the optimized solution had less effect on the environment.

Using LiDAR we achieved route optimization, less remove, environment protection, less labor work, process increase quality guarantee and created much profit for the client. Therefore, we should take LiDAR technology to powerline construction.



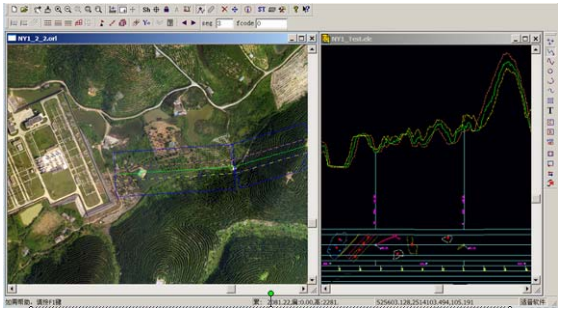


Figure4. powerline corridor Figure 5.section for optimization design

4.2 powerline checking

April, 2007 the most severe storm in fifty years threatened Supervoltage Company of North Grid's 308 kilometers length powerline. The storm made lines discharge large parts that affected the electric safety of Beijing. The company need to find all the places where the distance between lines was close enough to threaten the safety under the situation of powerline's normal operation. So as to install isolation sticks and support maintenance. We finished this job by put LiDAR system on a helicopter to get the lines' data. Through LiDAR techonlogy we offered precision was 5cm data to the client and help them solve their problem.

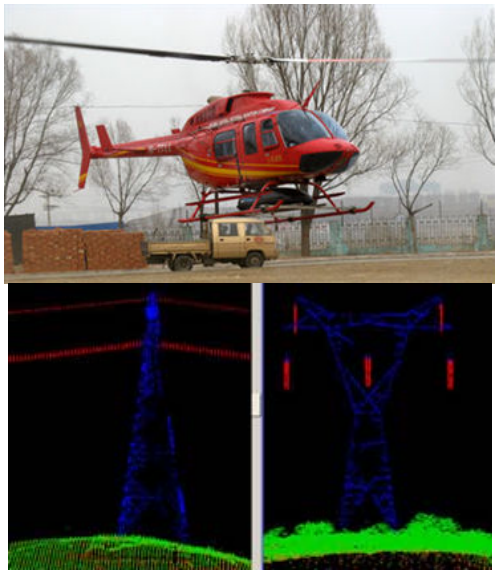


Figure 6. LiDAR system on a helicopter Figure 7. laser points of the tower

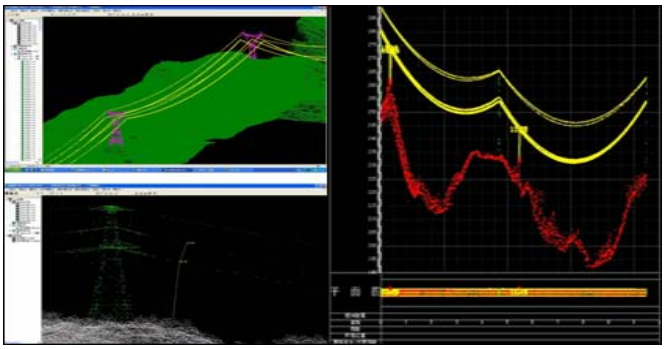


Figure 8. dangerous points checking

5 CONCLUSION

The practice of LiDAR in power grid construction and management proved this technology was prior to other means and could be used at the whole process of power grid construction and management. Chinese power grid's construction and management ways were out of date. Especially after Southern China's ice disaster of 2008 made the construction of digital power grid more important and enhanced the construction speed.

REFERENCES

http://www.gov.cn/jrzg/2006-01/06/content_149038.htm