3D VISUALIZATION COMPUTING IN FAST DESIGN AND CONSTRUCTION

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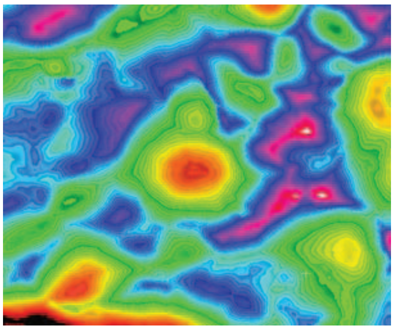
1. INTRODUCTION

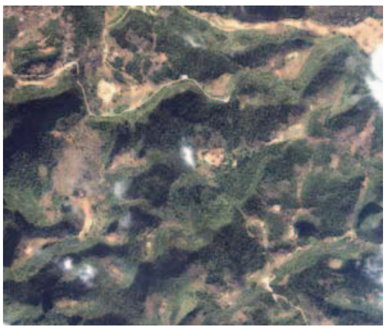
Five hundred meter aperture spherical radio telescope (FAST) will be the largest radio telescope in the world[1]. The innovative engineering concept and design have been paving a new road for realizing a huge single-dish radio telescope in the most effective way. The construction of FAST will fulfill many science goals, such as HI neutral hydrogen line survey, pulsar survey, largest station in VLBI network, spectral line observations and search for alien's technologies. More than one hundred researchers from over thirty research institutes are engaged in this program[2]. 3D visualization has become an important scientific tool, especially in the analysis of complex situations. As a result, an ideal 3D visual platform for scientists and engineers to cooperate in solving scientific and technological challenges has been provided in this research. Attempting to aid the design and construction of the gigantic project, this paper has developed some innovational methods, for instance, 3D terrain and massive main active reflector modeling based on QuickBird images and DEM , FAST central site selection, and cabin suspension towers location.

2. 3D MODELING

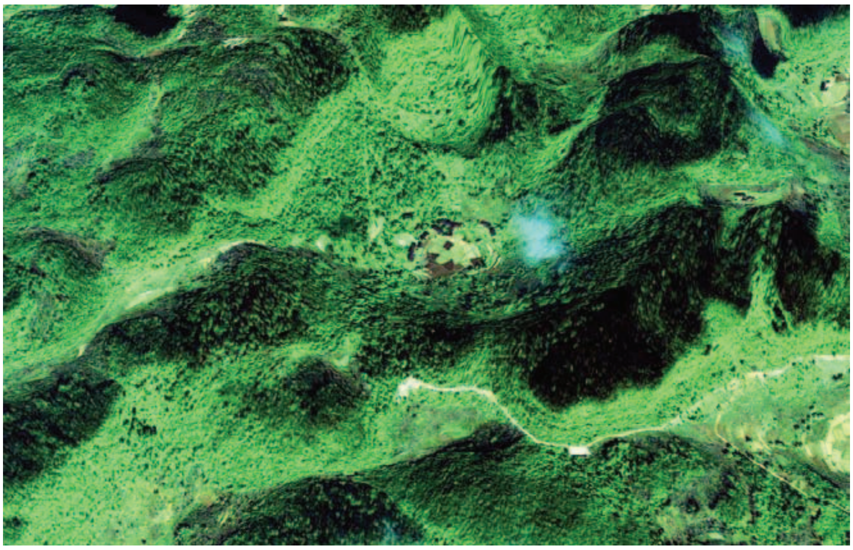
Based on remote sensing images and high-resolution DEM data, 3D terrain models have been created(Fig.1). To provide higher rendering quality, improved algorithm of level of detail (LOD) has been introduced to decrease the complexity of terrain representation in the interactive platform[3-5].



(a)



(b)



(c)

Fig.1. (a) DEM of Dawodang in the south of Guizhou;(b) QuickBird image of the study area;
(c) Interactive viewing of 3D terrain model based on DEM and image for FAST Analysis

3. SITE SELECTION

To build a large spherical telescope, the practical way is to make extensive use of existing depressions which are usually found in karst regions. Site surveying has been done for years in Guizhou province, including geo-morphological features and the distribution of the karst depressions, climate, engineering environment, social environment, and radio interference. At least 400 candidate depressions were investigated with remote sensing and the Geographic Information System. The expense of earthwork closely depends on the profile geometry of a depression. The site has been finally selected, a depression called Dawodang located in the south of Guizhou. However, a subtle distinction of the central site will result in thousands of m^3 earthwork fluctuation. In order to optimize antenna location in depressions and minimize the quantity of earthwork to be handled, data analysis were quantitatively studied by 1:1000 topographic maps and DEM. To calculate the volume of earthwork, we define terrain surface as $H_t = f(x, y)$ and telescope surface as $H_d = g(x, y)$. In the given area *D*, the volume of earthwork can be defined as:

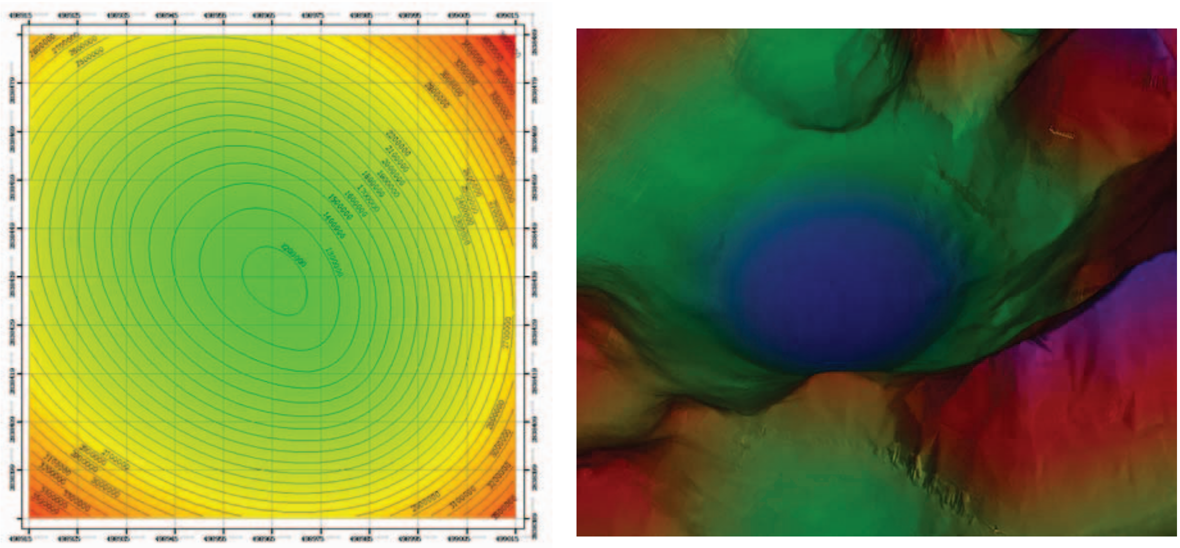
$$V = \iint_D [f(x, y) - g(x, y)]dxdy$$

Firstly, the computing model, with several parameters such as the radius of the hemisphere, the bottom height of the main active reflector, was carried out. In the key area of 2km*2km, the DEM data are resampled as 0.1m resolution, namely, the x*y pixels are 20000*20000. A hemisphere grid model is adopted to simulate the surface of the reflector, the minimum boundary rectangle(MBR) which is 5000*5000(the resolution is also 0.1m).

Then, the height of each cell (h_{ij}) is calculated by the model. The earthwork of each cell is noted as c_{ij}, and the x, y of the MBR are noted as M and N, so the total earthwork can be computed as:

$$C = \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} c_{ij}$$

Finally, the central area of 100m*100m is defined as optional region, and earthwork of every reflector in this area is computed with the center moving to optimize the location. The result is shown in Fig2.



(a) (b)

Fig.2. (a) Quantitative analysis of the central site selection in the optional region. The figure shows the earthwork of each central point in the area of 100m*100m(the unit is ten thousand m^3). The earthwork fluctuation is 99.4 to 397.2 with the reflector center moving. (b) The terrain after the earthwork was finished.

4. FEED SUPPORTING TOWERS LOCATION

The optimization of central site selection is one aspect, the distribution of feed supporting towers location is the other. The result shows as Fig.3.

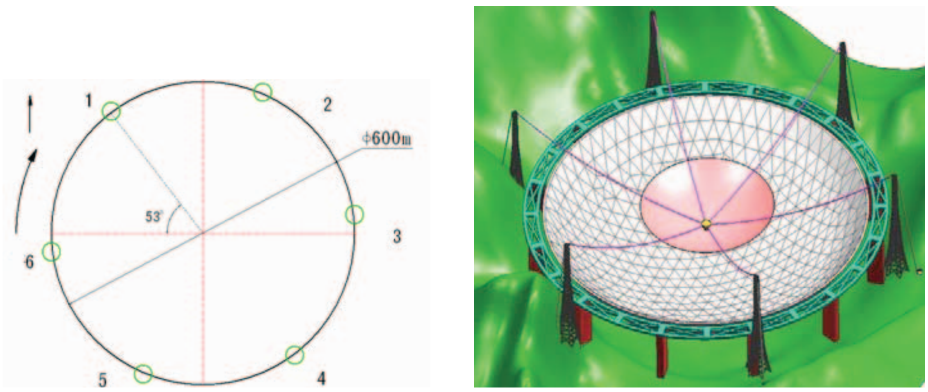


Fig.3. The optimized location of six towers

5. CONCLUSION

3D visual platform serves as a link among professionals from diverse fields, with which the design and construction of gigantic FAST becomes more effective. The methods of effective visualization and navigation for models are implemented in this paper. Some efficient algorithms in calculating the earthwork of FAST have been put forward , which are of great significance in estimating and monitoring the project processes..

6. REFERENCES

[1] Nan Rendong. “Five hundred meter aperture spherical radio telescope (FAST),” *Science in China: Series G Physics, Mechanics & Astronomy*, Vol.49 No.2 129-148, 2006

[2] Rendong Nan. “Introduction to FAST - Five hundred meter Aperture Spherical radio Telescope,” *Proc. of SPIE*, Vol. 7012 70121E-12,2008

[3] Yoon, Salomon, Lin, and Manocha, “Fast Collision Detection between Massive Models using Dynamic Simplification,” *Eurographics Symposium on Geometry Processing* , 2004

[4] J. Yang, Zh. Wang, Ch. Zhu, and Q. Peng. “Implicit Surface Reconstructi on with Radial Basis Functions,” *VISIGRAPP*, CCIS 21, pp. 5–12, 2007

[5] P. Lindstrom and V. Pascucci. “Visualization of Large Terrains Made Easy,” *Proceedings of IEEE Visualization*,San Diego, California, 2001