# Study on precise positioning and construction of improved varieties of forest seed base

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**Abstract:** In this paper, the cultivars of Pinus koraiensis and Japanese larch varieties in Liaoning Province were studied. Aiming to solve the problem of data update difficulty and lack of information management, the Kriging interpolation method and UAV (Unmanned Aerial Vehicles) and GPS technology positioning method were used for fine positioning of the improved varieties of forest seed base. Using linear comparison and distributed comparison method for accuracy assessment, 100 Pinus koraiensises were sampled by liner comparison method among which 10 were selected to be tested by distribution comparison method. With the help of the high density total station, the samples were measured and analyzed by the coordination. It showed the positioning accuracy was less than 1m, which met the need of the production of the forest seed base. On this basis, the tree seed production management information base database was established and the database structure design and structure design was made. Therefore, the managers in the forest natural reserve could use the database to plan and do the daily management, measure the area, the circumference, and the coordination of the forest natural reserve. In this way, the field work was lightened and it also provided support for the seed base management and production.

## 1. Introduction

The effective management of the good planting base of forest trees is the guarantee of the development of forestry construction. The organization and management of the good seed base is a huge and complex project [1]. The managers of good seed base should find out the problems in forest management and production in time [2]. We should fully recognize the necessity and importance of planning guidance for forest seed production [3]. The high tech means of information management is used to manage the good species of forest trees, enhance the scientific and technological input of forest tree seed [4].

Literatures on domestic forest seed base reveals the drawbacks like data update and management difficulty, digitization and informatization deficiency [5]. Furthermore, some of the existing drawings of the seed base do not match the authentic seed base. Some drawings are lost, resulting in the impossibility to trace back the male parent and female parent improved varieties. Other researchers only focus on the construction and countermeasures, the spatial arrangement, and benefit evaluation of the forest tree seed base, lacking the precise positioning and informatization. In this case, we take the cultivars of Pinus koraiensis and Japanese larch varieties in Liaoning Province as subject, and focus on the precise positioning and database constructing.

## 2. Research content and method

The indoor interpretation and field investigation, combined with the UAV technology and forestry management techniques are used to collect the basic data in the study area (seed orchard thinning design, seed orchard layout). The technology of geographic information system (GIS), UAV Remote Sensing Technology (RS) and the global satellite positioning technology (GPS) were used as well. Then, the data were processed by Smart 3D capture and pix 4D mapper software to generate results and data report of Laotudingzi forest natural reserve seed base for precise positioning and precision evaluation. Therefore, the production management information database is established.

### *2.1. Research area survey*

The research area—Liaoning Laotudingzi Forest Natural Resere is located in Fushun, Liaoning province. Up to 2013, the scale of the improved forest seed base was 3480 hectares, which was divided into the following functional group areas: the determination group, the breeding colony area, the seedgrowing area and the production group. The breeding area has 720 mu of Japanese larch junior clone seed orchard, 195 mu red Pine seed orchard, 150 mu Japanese larch 1.5 generation clonal seed orchard, 105 mu of mother forest of cleft leaf elm, 810 mu of the mangrove forest, 60 mu of yew trees, 90 mu of rowan trees and 45 mu of the mother woods of tianmu [6].

Liaoning Laotudingzi Forest Natural Reserve has rich tree seed base archives, thematic map complete, and detailed survey data, which provides favorable and rich data support for the research.

### *2.2. Data collection*

The collection of materials: Planting position of the seed orchard, tree planting location maps, the 1.5 generation seed orchard of Japanese larch, Xiaonancha red pine, Miaojia Gou configuration distribution map. UAV image collecting scope: The shooting has two main areas, respectively: 124 degrees to 124 degrees 54 '15.2 "56' 12.48" E, 41 degrees to 41 degrees 24 '22.514 "25' 18.47" N; 124 degrees to 124 degrees 54 '40.33 "54' 48.24" E, 41 ~ 25 '50.63 "to 41 degrees 25' 57" N, an area of about 40.7hm².

### *2.3. Kriging interpolation tree vertex extraction*

The digital terrain model and the canopy height model were generated under the ArcGIS software, the forest canopy with moderate to low canopy density was selected as the research object, combined with the high-precision DSM and DOM models. Open the Arc Toolbox, select the “3D analysis tool”, and use the subtraction in grid computing. The data settings are as follows: the DEM input is the subtraction, the DSM input is reduced, and the grid generation after the subtraction operation becomes CHM data.

Good seed vertex extraction: (1) Using the spatial analysis module, the neighborhood analysis below the block statistical function, the CHM data as the input data of the operation. (2) Using the 3D analysis module, the subtraction function is calculated under the grid, and the output image after the operation is the vertex image of the good base tree. (3) Using the space analysis module to reassign 0 and 1 assignments, and turn raster image of tree species into base vector data of tree species, and save them.

As the crown surface is curved and irregular, sometimes larger seed crown on multiple tree vertices, which means multiple maximum. In this paper, we use the method of vertex extraction from Wang Wei’s scholars’ tree base at Beijing Forestry University, and delete some pseudo tree vertices using the algorithm of the scholar, so that the new vertex map obtained is true vertex [7-9].

### *2.4. Unmanned Aerial Vehicle (UAV) and GPS technology positioning method*

In addition to the middle and low canopy density, the improved seeds are positioned by the combination of UAV technology and GPS technology. In order to ensure the accuracy requirements, UAV carries out high-precision control at the early stage of data acquisition. The quality of unmanned aerial vehicle (UAV) aerial film is improved by the way of post processing [10-11]. The basic process is as follows:

(1) To guarantee the high precision, one reference station in the known location of Laotudingzi forest natural reserve is established. Data is distributed through the network and recorded to the local area at the same time

(2) The high precision module record data is added to the UAV and the high precise position and IMU information of each photo are obtained by using the way point software.

(3) Finding some high precision phase space points on the ground, combined with the location information of aerial photographs, we use smart 3D software to process high resolution plane data and three-dimensional data.

(4) Adding field work in done: the high-precision hand-held machine is used to collect high precision trees with high precision and high precision. The results of the UAV positioning are shown in the following chart.

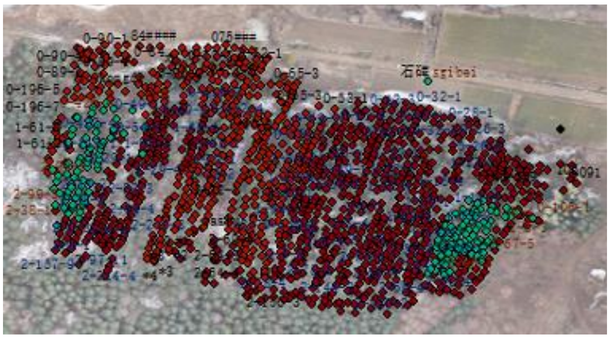

**Figure 1.** UAV positioning results.

## 3. Accuracy evaluation

The precision positioning data of the good species base are verified by using the linear comparison method and the distributed comparison method.

### *3.1. Linear analysis method*

A sample of 100 red pine trees in a small area of the good species base was selected to be tested (open, severely sheltered and adjacent to a number of trees). A high precision prism free total station was used to measure the sampled trees. The coordinates of 100 improved species were corrected by aerial photograph, and compared with the coordinates of the total station.

As shown in Figure 2, when the information collected by GNSS high-precision equipment is not fully, the accuracy can reach 1m, and the accuracy will exceed 3m when occlusion is fully. After using the aerial film to correct the error, the precision can be less than 1m. The location accuracy of individual trees is due to the tree skew growth, which leads to the difference between the center point and the tree vertex coordinates.

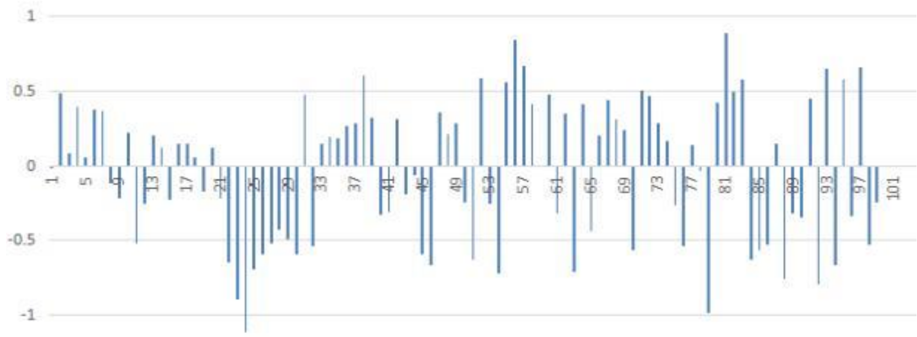


**Figure 2.** Airplane correction X error, (linear analysis).

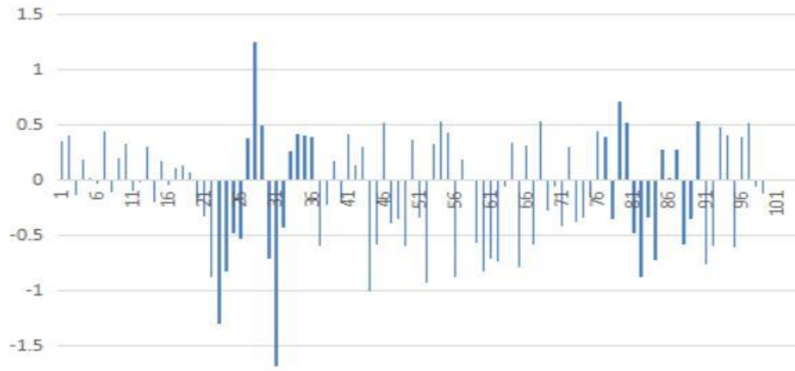


**Figure 3.** Airplane correction Y error (linear analysis).

### *3.2. Discrete distribution test*

10 representative points were selected randomly in the large area, such as severe occlusion, remote mountains, large chest diameter, small chest diameter, and a number of trees growing next to them. Only a few trees shade and aerial edge in the forest, the error is about 4m. GNSS equipment in the areas of severe occlusion can achieve sub-meter accuracy, as shown in Figure 4, after Aerial corrected, in the forest and open areas error within 1m, reached the seed base management precision [12].

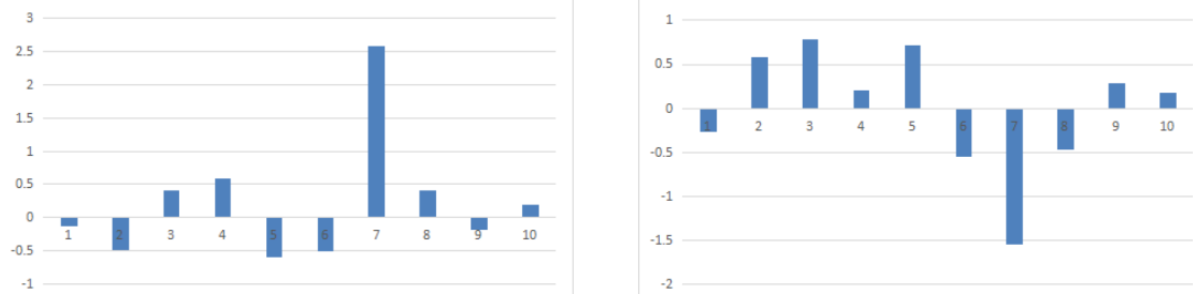


**Figure 4.** The X-deviation, Y-deviation (discrete distribution).

## 4. Establishment of information base for good species base

### *4.1. Database structure design*

Use arc catalog to create a spatial database, the desired layer is created according to the business needs: Plant germplasm (point layer map), cutting orchard, nursery, parent trees, experimental forest, seed orchard, progeny forest, and each layer involved in the field.

The field of state-level demonstration base of forest tree improvement includes: basic situation, auxiliary production engineering (including irrigation water source engineering, drainage engineering, road engineering, power supply communication engineering, protective engineering and so on), as shows in the following table:

**Table 1.** Laotudingzi Forest Natural Reserve layer attribute structure

| Serial Number | Field Name | Field Type | Length | Decimal | Unit |
|---|---|---|---|---|---|
| 1. | County | text | 6 | | |
| 2. | establish time | date | | | |
| 3. | introduction | text | 500 | | |
| 4. | water source project | text | 20 | | |
| 5. | drainage works | text | 20 | | |
| 6. | road project | text | 20 | | |
| 7. | power supply communication engineering | text | 20 | | |
| 8. | protection engineering | text | 20 | | |
| 9. | area | double | 16 | 2 | hectare |

The tree seed base (cutting orchard, seed orchard, progeny forest, parent trees), the fields include: the basic situation, clonal disposition, project, scale, clonal origin, pest control, quantity, tree management, fire protection management.

The nursery fields include the basic situation, the nursery area, the road engineering, and the production supporting facilities and so on.

The production engineering fields include: basic conditions, water supply engineering, power supply communication engineering, protection engineering and production facilities and other fields.

### *4.2. Data loading of good species base*

Design survey of forest resource planning (second class investigation) sub-compartment data layer, as a reference, to determine the scion, nursery, parent trees, experimental forest, seed orchard, forest layer range according to the image and data of sub-compartment.

Spatial data and attribute data entry: the collected data is processed into SHP format by software. After data preprocessing and excel connection, the data is loaded and integrated into the individual germplasm layer.

### *4.3. Information base function*

The characteristic functions of the information base of the good species base are as follows:

(1) Statistical analysis:

Through spatial overlay analysis, how many seeing germplasm can be analyzed in a seed orchard (or mother forest); how many classes within the area, what are the dominant tree species among the classes, the accumulation of information, the DBH(diameter at breast height) also can be analyzed. It can also can realize the commonly used information statistical function: maximum analysis value, minimum value, average value and so on. As shown in the following figure:

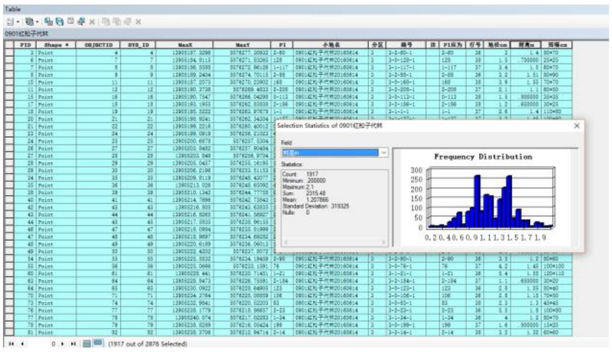


**Figure 5.** Analysis of statistical results.

(2) Distance measurement:

We can query the distance between tree and tree, the distance from tree to road, and the distance between nursery (or seed orchard, mother forest) and road (river).

(3) Query browsing:

Spatial query, the selection of germplasm in the area of interest can be selected according to the location.

Attribute query, attribute query basic information through query interested accessions, including small names, tree species, tree height, DBH, crown width, and so on.

(4) Three dimensional display function:

By using the three-dimensional display function, we can simulate the growth of each improved variety, and assist the managers of the reserved area to plan and manage the improved seed base. It is also possible to measure the area, circumference and coordinate of the good species base in the reserved area. And reduce the workload of field work measurement. The measurement of area and perimeter is as shown in the following chart.

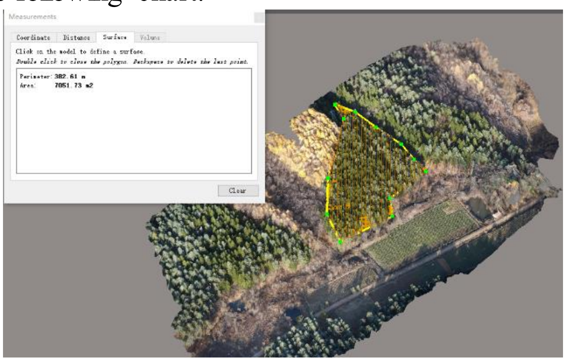

**Figure 6.** Circumference of the measurement.

## 5. Conclusion

(1) Tree vertex extraction can be done by using the Kriging interpolation method, combining with UAV and GPS positioning method, the completion of the seed base of precise positioning and precision evaluation is realized.

(2) After precise positioning of the improved seed base, using linear comparison and distributed comparison method for accuracy assessment, 100 Pinus koraiensises were sampled by liner comparison method. 10 out of 100 Pinus Koraiensises were selected to be tested by distribution comparison method. With the help of the high density total station, the samples were measured and analyzed by the coordination. It showed the positioning accuracy was less than 1m, which met the need of the production of the forest seed base. The high positioning precision also meets the needs of field work investigation and management of the improved tree seed base.

(3) The establishment of Laotudingzi forest natural nature reserve seed base information database, Therefore, the managers in the forest natural reserve could use the database to plan and do the daily management, measure the area, the circumference, and the coordination of the forest natural reserve. In this way, the field work was lightened, and it also provided support for the seed base management and production. It has realized the management mode from the original paper data management to the digitalization.

**Reference:**

[1] Shen X H 2004 Opinion on the current work fine breed base in Liaoning *Liaoning Fores. Sci. Tech.* **01**: 29-31
[2] Om P Rajora 2001 Challenges and opportunities for conservation of forest genetic resources. *Euphytica Springer J.* **4**: 136-7
[3] Tiit Maaten 2010 About management and research of forest genetic resources *Fores. Studies Metsanduslikud Uurimused* **02**: 56-7
[4] Hu C 2014 Study on GIS-based Planning and Layout of Metasequoia glyptostroboides in Hubei Province *J. Northwest Forest. Uni.* **02**: 70-2
[5] Wang X J 2005 Study on tree species recognition and plant location method based on large scale aerials *J. Northeast Fores. Uni.* **05**: 60-5
[6] Li J J, Liu D D and Lv R 2016 Old bald sub-national nature reserve scientific research report *Shenyang Press,* Shenyang, China :11-65
[7] Wang W 2015 *J. Beijing Forest. Uni.* **04**:23-5
[8] Vera R 2011 a gis-based mapping and estimation the current forest landscape state and dynamics *J. Landscape Ecol.* **4**: 34
[9] Julia 2008 Factors affecting the accuracy of forest clear-cut area estimation on medium spatial resolution satellite winter images *Forestry Studies Metsanduslikud Uurimused* **05**: 122-4
[10] Zhao J, Liu D L, Zheng X X, Zhao X M and Zhao H S 2010 Application of GIS to Study on Multi-function Operation in Jingouling Forest Farm *J. Northwest Forest. Uni.* **25**: 207-9
[11] Stere K. 2016 UAV and GIS based tool for collection and propagation of seeds material-first results *Remote Sensing Spatial Inform. Sci.* **07**: 213
[12] Liu D D and Zhao J 2004 The precise location research of the good breeding base -- Taking the old bald nature reserve as an example *Liaoning Forest. Sci. Tech.* **01**: 29-31