

The Theory of the Position Line and Position Navigation Software System

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Abstract

This paper consists of two parts covering the positioning navigation software with position line and it's theoretical basis. The software system is considered as an inventive devotion to position line theory and application.

Introduction

The position line is one kind of contour line which is composed of points that their geometric parameter is equal. The research of position line is an important part of Modern Mathematical Cartography. It is the basis of positioning-navigation software system with position line. This software system has many functions, such as mathematical Cartography, computation of position line and graph positioning, etc.

1. Theoretical basis of positioning-navigation software

The Position line theory and application is the theoretical basis of positioning-navigation software. It includes:

1.1 Position line theory

the defination and equation of some useful position line, such as: constant bearing line, great-circle line, small-circle line, hyperbolic line and loxodromic line.

two kinds of parameter equation of circle position lines are

$$\alpha = F_1(\varphi, \lambda), \quad s = F_2(\varphi, \lambda)$$

and $\varphi = f_1(s, \alpha), \quad \lambda = f_2(s, \alpha)$

Forward solution of geodetic problem on the sphere, that is: supposing the following parameters are known: spot1(φ_1, λ_1), spheretical dis-

tance s from spot 1 to spot 2 and azimuthal angle α_1 , how to find spot 2 (φ_2, λ_2) and its azimuthal angle α_2 .

Inverse solution of geodetic problem on the sphere, that is, supposing spot1(φ_1, λ_1), spot2(φ_2, λ_2) are known, how to find s , α_1 and α_2 .

Ellipsoid solution of geodetic problem presents the equations of geodetic and mathematical model for long-distance position computation and inverse computation.

We have found the coordinate transformation for position-line computation and objective-spot, which include:

- equations of great-circle line and small-circle line on projection face and a certain kind of mathematical model for easy projection.
- gnomonic projection for projection transformation of objective spot computation, and two methods: graphic computation and analysis computation.
- stereographic projection for projection-exchange of objective spot computation.
- projection equation of ellipse, hyperbolic curve on sphere.
- theory of using straight line instead of curve, including the equation for limit of distance, the methods for auto-drawing of position line.

1.2 Application of position line

great-circle and small-circle position line used in thematic mathematic element map, such as: Distance-Angle measuring map, great-circle track map, great-circle navigation map, etc.

great-circle and small-circle position line used in wireless electronic navigation and positioning, including three kinds of positioning methods:

- $s-\alpha$ positioning, using distance s and direction angle α
- $\alpha-\alpha$ positioning, using the direction angles from two different stations to the object
- $s-s$ positioning, using the distances from two different stations to the object

We give the mathematical models of intersection computation for

angle-measuring.

We also give the methods of hyperbolic curve positioning.

1. 3 Application of GPS in cartography

- positioning and navigation.
- finding sub-satellite track.

2. Positioning-navigation software system

This software system includes four parts: Application software of digital map for administrative map, geodetic problem computation software, position-navigation software with position line, projection transformation software.

2. 1 Software for digital map data-processing and application

- software of map data handling and graph plotting
- digital map of China on the scale of 1 : 6000000
- digital map of the world on the scale of 1 : 50000000

2. 2 Software for solution of geodetic problem

- direct or inverse solution of geodetic problem on the sphere
- direct or inverse solution of geodetic problem on the ellipsoid

2. 3 Software for radio-range orientation and navigation

- radio-range orientation by angle-measuring
- radio-range orientation by distance-measuring
- radio-range hyperbolic positioning

2. 4 GPS application software

- GPS positioning
- GPS navigation
- Sub-satellite point track projection

2. 5 Thematic mathematical element software

- auto-plotting grids of distance-measuring and angle-measuring in different projection
- auto-plotting grids of hyperbolic navigation
- auto-plotting plan navigation line and range line

2. 6 Software for map projection transformation

- some common-used map projection transformation and latitude-longitude grids auto-plotting

Conclusion

“Position and Navigation Software System of Position Line ” on the basic of deep theory, has abundant contents, rational design ,complete functions and easy operations. It has many uses.

Cooperated with digital map, it can be used displaying and tracing of wireless location and navigation in real time, displays quickly the range line、direction line and sub-satellite point track on back of the world map, reads instantly distance and position angle from the center point to the target point and provides for surveying-mapping business unit the screen display and graphy output of various thematic mathematical element map such as plan navigation line map ,flying range map ,distance-angle measuring grids map and hyperbolic navigation map, etc.

This system, advanced and practical, has produced considerable economic results. therefor it is a creative accomplishment in position-line theory and application. It has broad application prospects.

References

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